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COMPRESSED AIR MAGAZINE

PUBLISHED BY THE

Compressed Air Magazine
Company

EASTON, PA.

NEW YORK, N. Y.

VOLUME XV

117296
13/7/11

JANUARY TO DECEMBER,

1910.

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COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV JANUARY, 1910 No. 1

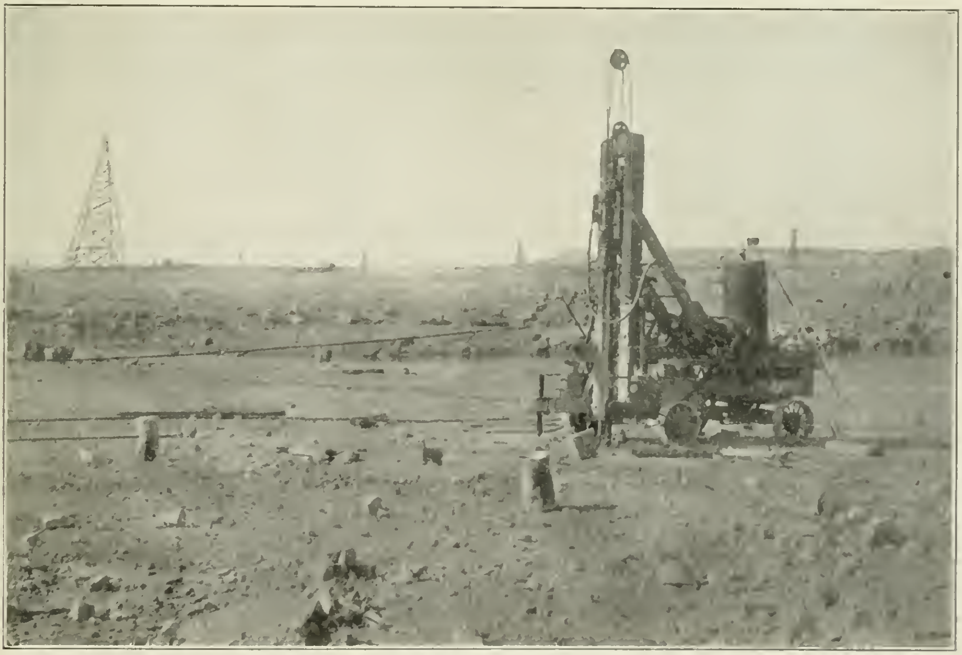
A NOVEL LOCOMOTIVE ROCK DRILL AND A REMARKABLE DRILLING RECORD

BY FRANK RICHARDS.

Successive "new records" made in rock cutting operations are often not fairly comparable with either preceding or succeeding records elsewhere made, on account of the differences in the conditions under which they are made. Thus the rock-drilling record set forth in the following may not be properly comparable with performances in other cases of rock-drill work. But it is sufficiently striking and notable in itself, and may point the way toward more efficient methods of wide applicability.

This record was made in the work of excavating the Livingstone Channel, a detail of the improvement of the Detroit River. Here was a straight channel to be cut in rock, 300 ft. wide, in the bottom of the river. The contractors for the section in question are Grant, Smith & Company & Locker; the work lies between Amherstburg, Ont., and Grosse Isle, Mich.

The area to be worked over was enclosed by cofferdams at each end, so that the operations were entirely "dry." The entire site was



LOCOMOTIVE ROCK DRILL. DRILLS DEEP HOLES WITHOUT CHANGING STEELS.

commanded by three Lidgerwood cable conveyors movable lengthwise of the channel as the work progressed; these conveyed all the material from the excavation and dumped it at a sufficient distance on either side. The overlying earth and loose stones were first removed by the aid of steam shovels, with which operation we at present have nothing to do, and then there remained a clear surface of rock to be excavated to a varying depth up to 12 ft. and over. The material is a soft lime rock running into dolomite and is unusually free from seams, making it a comparatively easy proposition for the rock drill.

The drilling over the entire surface was all done in a single operation to the required bottom level. In commencing the drilling what might be called a standard equipment was employed, consisting of the usual type of rock drills, air operated, mounted on tripods and requiring two men for each. These drills were moved from hole to hole, usually a distance of about 8 ft., as required. These, of course, required a change of bit for every 2 ft. of depth of hole drilled, and a successive reduction of gage for each additional steel, so that to drill to a depth of 14 ft. and a bottom diameter of 3 ins., seven steels would be required with 3¾ or 3 7-8 ins. for the starter. The actual average rate of the drills on this work was about 46 ft. of hole for an eight-hour shift. Four 3 1-4-in. Ingersoll-Rand drills were crowded all the time to keep one cable conveyor occupied.

The half-tone herewith shows the arrangement which has revolutionized all this. It is the invention of Mr. C. H. Locker, of the firm above referred to. It comprises in fact a single rock drill with a carriage and mounting and air-power devices which enable it to keep at work, actually drilling, as constantly as possible and *minimize the delays* required for shifting from hole to hole, for changing the steels, and for raising the drill by the feed screw when either change is made. This drill has largely made its record by avoiding stops, just as the big through express trains do. It has also the additional advantage of extra weight and power, which would not be practically available in a drill entirely operated and moved about by hand.

As seen in the half-tone, there is a horizontal frame built of heavy timbers and mounted upon four wide-tread wheels, those in front being on a fixed axle while those in the rear are swiveled for steering. There is a vertical air receiver or "air dryer," as they call it, on the rear of the platform and in front of this is a two-cylinder reversible hoisting engine which supplies the power for the several operations required. An extension of the shaft carries a small sprocket-wheel which connects by a chain to a larger sprocket driving the front carrying-wheel when the machine is to be moved. In front is a vertical heavily braced gallows-frame which carries the drill. When everything is in place the preponderance of weight is upon the front wheels, which is as it should be, and when the apparatus is in exact position for starting a hole the two jackscrews seen in front are set down solid upon the rock taking most of the weight and holding everything rigidly in place. The manipulation of these jackscrews is the only hand operation involved when changes of position are made.

The drill used in this case is a 5-in. Ingersoll-Rand machine ("H2"). The first change made in it was to dispense with the usual shell or guide in which the drill cylinder travels up and down by the operation of the slow-acting feed screw. In place of the drill shell the front of this carriage provides vertical guides in which the drill cylinder fits as in its original shell, but with a travel of 10 ft. instead of 2 or 2½ ft. The drill is suspended by a wire cable of suitable size carried to the drum of the hoisting engine, one or two revolutions of which will raise the drill from the bottom to the top of the guides.

A single steel is used of sufficient length to take advantage of nearly the entire vertical travel of the drill cylinder. The feed is entirely by the suspended weight of the drill, a slow retrograde movement of the hoisting drum being accomplished by a worm gear arrangement which can be clutched in or out as required (as is also the fast speed for hoisting the drill and withdrawing the steel from the hole). Holes to a depth of 8 ft. can thus be drilled with a single steel without a stoppage, and the loss of gage in the operation is in this rock scarcely noticeable. For keeping the drill in place when starting there is a guide attached to the front of the machine and brought down quite close to the rock. This guide of course does not fit the steel but gives it a little liberty to dodge around, while still locating the beginning of the hole with sufficient accuracy. The front half of this guide is hinged and can be swung back out of the way when changing steels.

It is not necessary to describe this apparatus any more in detail. It is evidently a crude and, in a way, merely an experimental arrangement; even the air hoisting-engine was home-made. The machine is already beisg replaced by a carefully designed machine constructed entirely of steel and with additional provisions for economy and facility of operation. However, such as it is it has worked steadily for two or three months or more and made astonishing records.

The following figures are given by a responsible and careful observer. On Sept. 23, 1909, drilling 3-in. holes, 29 ft. of hole was drilled in 55 minutes. This incluuded moving the drill four times, the time occupied in moving being about 45 seconds each. On another day the drill was timed for one hour. Handicapping the drill in this case was dull steel and low air pressure. Yet the first hole was drilled to a depth of 7 ft. 8 ins. in 7½ mins., the next hole was 6 ft. 6 ins., in 26½ mins., and at the end of the hour, with five moves, 37 ft. 3 ins. of holes had been drilled.

The following is from another observer: In 32 mins. it put down three holes, 6 ft. 2 ins., 7 ft. 2 ins. and 7 ft. 2 ins., and was moved three times, leaving it ready for the fourth hole, all in 32 mins. In this time there was a delay of 4 mins. caused by the driller neglecting to raise his bar and getting it bent.

The 6 ft. 2 in. hole in this case from start to finish took 5¼ min. The time of moving, that is from when one hole was finished until another was started, was exactly 2 mins.

The performance of this machine is more strikingly expressed, however, by the following statement: Operated by two men, it took the place of the four tripod drills and eight men, and easily kept well ahead of the conveyor at all times. Its work compared with the tripod drill was approximately as *five to one*. The saving of air consumed has not been investigated.

On the new machine a reheater will be installed, and also a supplementary compressor to generate high-pressure air to follow the drill into the hole and blow out the dust.

EMERGENCY OXYGEN CUP FOR MINERS

The half-tone here reproduced from the Scientific American shows a life-saving apparatus invented by Mr. Clarence Hall, who is in charge of the explosives experiment station at Pittsburg. The device is a simple appliance which generates sufficient oxygen to sustain life for half an hour or so under any conditions of atmosphere. When it is used in an emergency it will guarantee an extension of life for a time extending to half an hour or even an hour, while a man is fighting his way to the open or awaiting the coming of rescuers.

INDIVIDUAL OXYGEN SUPPLY.

Mr. Hall was lighting the lamp of an automobile when the idea occurred to him to generate oxygen just as the acetylene for his lamp was generated, and providing the means of supplying the oxygen to miners or others whose supply of air fails them. There is in the apparatus accordingly a water chamber, and below it a compartment filled with sodium peroxide.

When the emergency rises a stopcock is partially turned, the water comes in contact with the chemical and oxygen is liberated. It is passed through the water, which cools it and then it goes to the mouth and nose which are covered by a mask such as is fitted to the face when gas is administered by a dentist. Oxygen may thus be supplied that will keep a man going for at least half an hour while he fights his way out of gas or smoke.

Mr. Hall as a representative of the government studied many of the great disasters in mines that have occurred in recent years. At Mononga, where more than three hundred men lost their lives in December, 1907, he found that the vast majority of the men had died by slow suffocation long after the explosion. Many of these had crawled for great distances on their hands and knees, for the miner knows that the best air is near the ground. Their trousers were worn through at the knees, and their blood marked their trails. Their fingers were worn through to the bone from crawling.

Of all men who die in mines, ninety per cent. meet death through suffocation. There are in the United States 700,000 men who work in coal mines. Many of these are daily subjected to the danger of suffocation. Every year 4,000 of them go to their deaths in this way. The ordinary safety devices are expensive. The men cannot have them always at hand, even if they could afford the expense. The new device can be slipped into the coat pocket, and kept with the coat and lunch basket, always within reach.

The explosion experiment station which Mr. Hall is in charge of, has among other arrangements a large chamber in which all sorts of poisonous gases may be confined, and into which men are sent to demonstrate different appliances. Various kinds of oxygen helmets which will keep a man going for two hours were tried out here.

In this demonstration chamber Mr. Hall burned excelsior in the chamber until the smoke was so thick that the eye could not see four inches through it. Then he donned his oxygen-producing device and went in. He remained here quite comfortably for fifteen minutes. Then the smoke pained his eyes and drove him out. The device continued to generate oxygen, and other men entered the chamber with entire safety for more than half an hour.

APPLICATION OF ELECTRICITY FOR PURIFYING AIR

BY J. W. BUZZELL, ASSOC. M. AM. SOC. C. E., AND WILLIAM H. LARKIN, JR., M. AM. SOC. M. E.

Notwithstanding the wonderful strides made in the reduction of cost and time by the use of machinery, mixed concrete is still conveyed into place by the same crude, slow and expensive methods that existed from the first, namely, wheelbarrows, carts, cars, buckets, chutes, etc., requiring enormous proportional outlays for runs, trestles, railways, engines, derricks, and other plant, as well as cost of operation and maintenance of same. These crude methods have other marked disadvantages. Concrete handled by wheelbarrows, carts, buckets, etc., is subject to considerable waste and tends to set in transit, particularly where transported considerable distances, as is frequently the case. Concrete construction is often from necessity carried on in cold weather subjecting the concrete to the danger of chilling; therefore, any apparatus that conveys the mixed concrete instantly from the mixer into place is particularly desirable.

With the idea of devising some method by which the transportation of the concrete mixture might be simplified the writers of this article some years ago started experiments on forcing the wet mixture through pipes by means of compressed air. The writers were then engaged in the construction of a difficult piece of concrete work where it became necessary to place the concrete by causing it to flow through a long length of pipe placed in an approximately vertical position. It was thought at the time that if the force of gravity would cause the concrete to flow downward through the pipe, there was reason to believe tat concrete could be made to flow through a pipe in any position when acted upon by some force other than gravity, such as steam or air pressure.

This conclusion was not arrived at until considerable experimenting along other lines had been done. The first trials were made by attaching the suction end of a large centrifugal pump to the discharge end of a concrete mixer, which scheme proved to be a failure, due to the fact that the stone separated from the sand and cement and discharged separately. The first encouraging results were brought about by attaching a large steam pipe to the pump casing, thereby introducing a pressure into the body of the pump which acted upon the mass of concrete in it, causing it to discharge in a more satisfactory manner. These experiments led to the design and trial of a cylindrical receptacle provided with a sealable opening at the top for the admission of mixed concrete, a discharge pipe and valve at the lower end and means for introducing pressure at the top. The discharge pipe at the lower end led to the place where the concrete was to be deposited. Upon applying pressure the concrete was instantly forced through the pipe and deposited in the same condition as when introduced into the receptacle. Many minor difficulties were encountered during the experiments, which, however, were overcome and patents were secured on the process and apparatus.

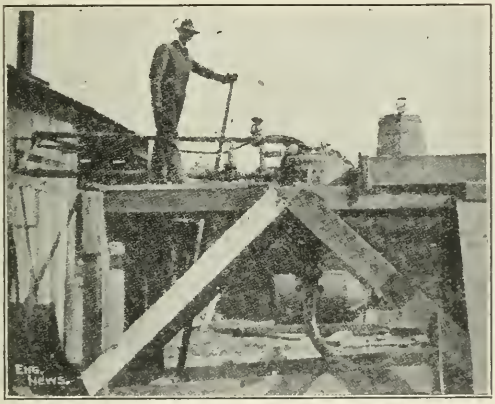


FIG. 1.

In order to obtain necessary engineering data, other more elaborate experiments were conducted using the same type of apparatus and covering a period of several months, during which the photographs reproduced in the accompanying half-tones were taken.

The device used in the experiments consisted of an iron tank (Fig. 1) provided at the top with an air-tight gate, on the side with a pipe entrance for the compressed air and at the conical bottom with an exit pipe for the concrete. Concrete was first mixed on a board at the top of the hopper and poured into the tank through the upper gate which was then battened tight. Simultaneously, then, valves on the intake air pipe and the outlet concrete pipe were opened and the compressed air forced the concrete out of the tank through a 4-in. pipe, to the point of exit. The 4-in. pipe used to transmit the concrete was about 400 ft. long and contained several 90 degree bends and one 180 degree bend with a 4-ft. radius. There seemed to be no obstacle to the use of a much longer pipe had it been convenient at the time and place.

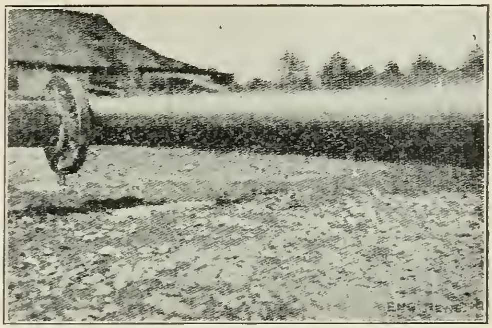


FIG. 2.

Tests were carried on with air pressures up to 100 lbs. per sq. in., but it was found that 50 lbs. was the most efficient. Under this pressure the concrete mixture was forced out of the end of the pipe in a well-mixed mass, but at a velocity too great for practical work (Fig. 2). To reduce this velocity a nozzle, such as shown in Fig. 3, was devised. This is simply a plank box with a curved upper cover which diverts the fast-moving stream of concrete and drops it, thoroughly mixed, on the ground or, on actual work, within the forms.

The concrete was hand mixed, of 1:3:5 proportions, and was made with stone up to 2-in. diameter. About as much water was used as in ordinary reinforced-concrete work, that is, it was a fairly wet mixture.

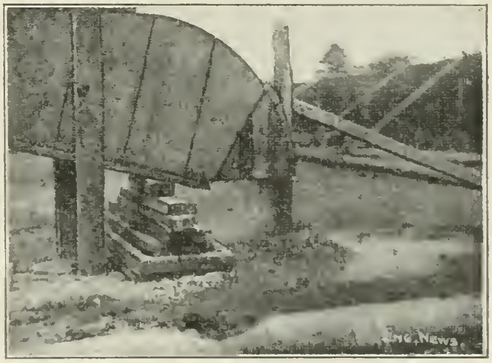


FIG. 3.

The main object of these experiments was to determine the amount of power necessary to convey concrete through pipes of different sizes and lengths; and the coefficient of friction between the concrete and the pipe so as to make possible the use of Bernoulli's Theorem in the design of other apparatus.

Inasmuch as during experiment concrete was deposited without difficulty at a height of about 100 ft. above the mixer through a vertical pipe line it is reasonable to assume that it can be conveyed by this means to any height that would be encountered in ordinary construction.

The process of making concrete resolves itself naturally into several separate and distinct divisions, namely: Manufacture of cement; the handling of cement, sand and stone; meausring, feeding and mixing the aggregates; conveying and placing the concrete. The invention of the rotary kiln, and numerous devices for measuring, feeding and mixing the aggregates, has reduced the cost of concrete to a point where it is now used on all classes of construction. Inasmuch as the greatest factor in the present cost lies in the conveying and placing of the concrete it would seem that these experiments in pneumatic conveying offer a solution of the problem of still further reduction in cost, as statistics obtained during these experiments show that on works of even moderate magnitude concrete can be conveyed by pneumatic means for less than 10 cts. per cu. yd.—*Engineering News* (slightly abridged).

APPLICATION OF ELECTRICITY FOR PURIFYING AIR

New applications of electricity are being discovered daily but not every new application is of such interest or importance as one recently developed for purifying the air of reading rooms, theatres and other close places where large numbers congregate. The apparatus referred to is the ozone generator made by the National Air Filter Co., Chicago, a large installation of which was recently made in the Chicago Public Library to purify or ozonize the 10,000 cubic feet of air per minute that is forced into the main reading room. Dr. W. A. Evans, health commissioner of Chicago, declared that the air in the library building prior to the installation of the apparatus was entirely unfit for use, being foul and dangerous, and probably no other building in the city has been subjected to more condemnation because of its defective ventilating system than it. After the installation of the ozonizing apparatus it was found that the main reading room was completely deodorized, the air being freed of that disagreeable and deleterious odor which for years had so thoroughly permeated all papers, books, furnishings, etc., in this large room. The fresh sterilized "mountain" air in the room reduced the humidity during the hot, oppressive days of summer, and greatly increased the comfort of the readers and employes. The installation renders the disinfecting of all books, periodicals, papers, etc., on the shelves, racks, tables, etc., an automatic process, keeping them constantly in a hygienic condition.

The ozone generator is installed in the large air duct and measures 6 feet high, 11 inches thick and 1 foot wide; it consumes 6.5 amperes of current per hour while ozonizing 15,000 cubic feet of air per minute. A connection is made with a feed wire of 110 volts to a step-up transformer which discharges a current at a potential of 7,000 volts. The high-tension current feeds into a series of electrodes made in the form of ordinary hairbrushes. A static electrical discharge is maintained playing against a series of glass plates. Through this blue electrical discharge of 7,000 volts, air is forced, the result being that all bacteria, germs, etc., are electrocuted. When the filtering electrodes become dirty or clogged they are simply rubbed together and cleaned as one would clean an ordinary hair brush. The generator is placed between the fan and the spray of water used in washing the air, to prevent losing the ozone which the water would otherwise naturally take up.

The low consumption of current and consequent low maintenance cost makes the ozone generator feasible for purifying the air of shops, mills and factories where difficulty is experienced in supplying air in large volume free from odors. It is of commercial importance for preserving and restoring food and other products affected by odors or quickly tainted by decay. Ozone has been found to completely deodorize stale milk, cream, butter and other creamery products, and other uses for the process are constantly being discovered. It is being used for aging wine, curing tobacco, tanning hides, purifying water, etc.—*Machinery.*

COMPRESSED AIR FOR CLEANING AND PAINTING METAL

The following we take from a report by Mr. George L. Fowler to the American Bridge and Building Association. It will be seen that the writer strenuously objects to the use of compressed air for the painting operation, giving substantial reasons for his objections, which are all based upon the moisture in the air, and it would seem that if the air were dried by any means it might still be satisfactorily employed.

I have found, he says, the air spraying system of painting to be very injurious to the durability of oil paints. Paint can be laid by this process quite smoothly, but it will not last. The reason is a simple one:

Air always contains more or less moisture in suspension and the warmer the air, the greater the quantity that can be so held. Hence, an atmosphere that may be warm will be perfectly clear, even though the amount of contained moisture may be very high. But, if that air is cooled, clouds and fogs immediately appear because of the precipitation of the moisture.

This is what happens in painting with compressed air. The warm compressed air is usually pretty well saturated with moisture. As it leaves the spraying nozzle, it at once expands and, in so doing, its temperature falls, and some moisture is precipitated. This moisture is, at the time, intimately mingled with the particles of paint and is thus imprisoned in the film that is formed on the surface. The result is moisture in the body of the paint and rapid deterioration.

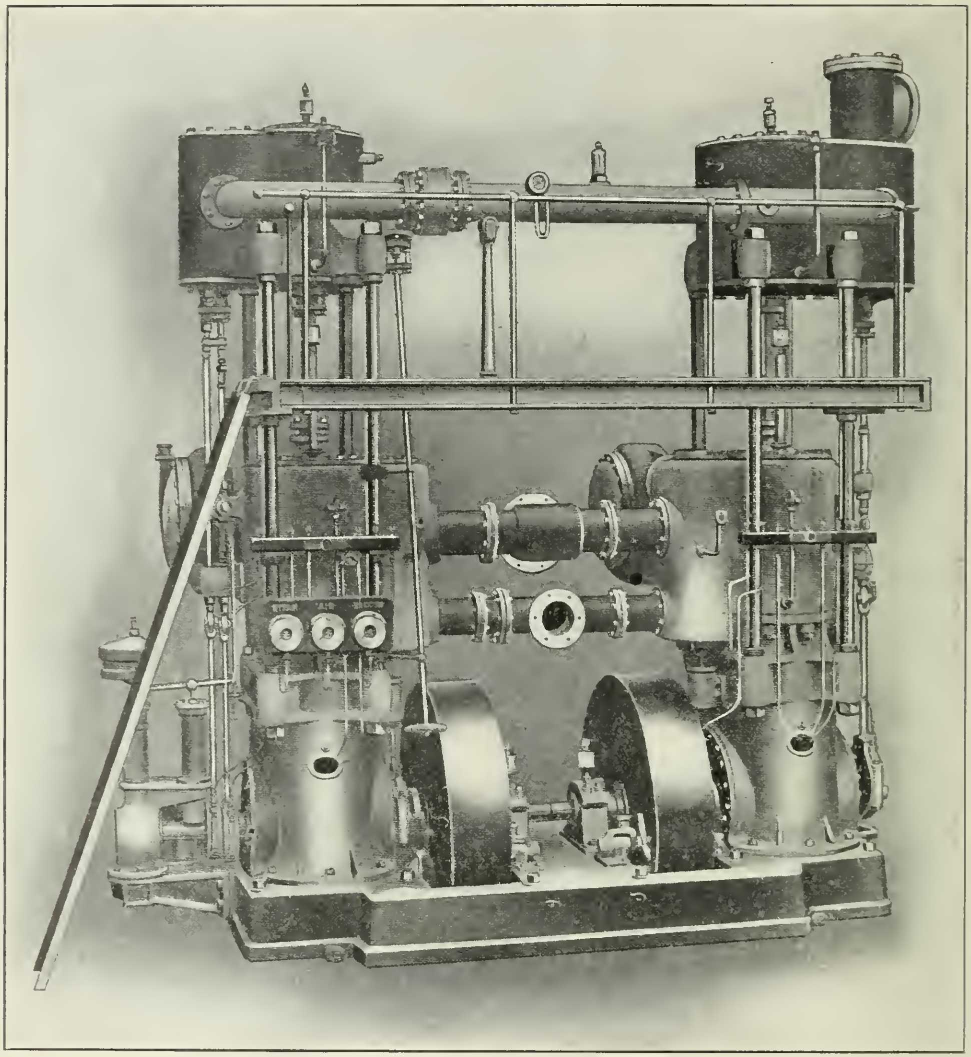
For cleaning, that is by sand blasting, there is nothing that equals it. In fact, I know of no other way in which a surface can be properly prepared. Wire brushes simply cannot remove the rust and, even if they could, they would leave the surface so covered with a fine dust, that any paint laid over it would have the elements of its own destruction embedded in it. But the residue of rust is the principal evil to be guarded against. For example: In some of my investigations I had subjected a paint to an action for several months without apparent injury other than a dulling of the surface gloss. It appeared to the eye to be in proper condition for repainting. Before doing this, however, I examined it under the microscope and found it to be totally unsuited for repainting. I found that minute blisters had arisen on the surface and that many of these had burst, leaving a small crater-like hole in the center. This hole was about 1-2000 in. in diameter, but down in the bottom of it I could see the red rust that had formed on the bared metal. If, then, the plate had been repainted, there would have been a rapid deterioration of the surface and for no apparent reason. You can see, then, that this serves as an explanation why it so frequently happens that the repainting of a structure with the same paint originally used is so unsatisfactory while the original painting was all that could be desired. Scraping and using a wire brush cannot get at these microbes of deterioration, as they may be called, and I know of nothing but sand-blasting with compressed air that will.

A VERTICAL CROSS COMPOUND STEAM AND DUPLEX TANDEM TWO STAGE AIR COMPRESSOR

The half tone and the large line cut here reproduced from The Engineer, London, show the essential features of an interesting air compressor recently built by W. H. Bailey & Co., Limited, Manchester. The air and the steam cylinders are here combined in such a way that the whole may be operated together as a compound machine or either side may be operated separately. The steam cylinders being mounted above the air cylinders, their expansion and contraction do not affect the air cylinders or other parts of the machine.

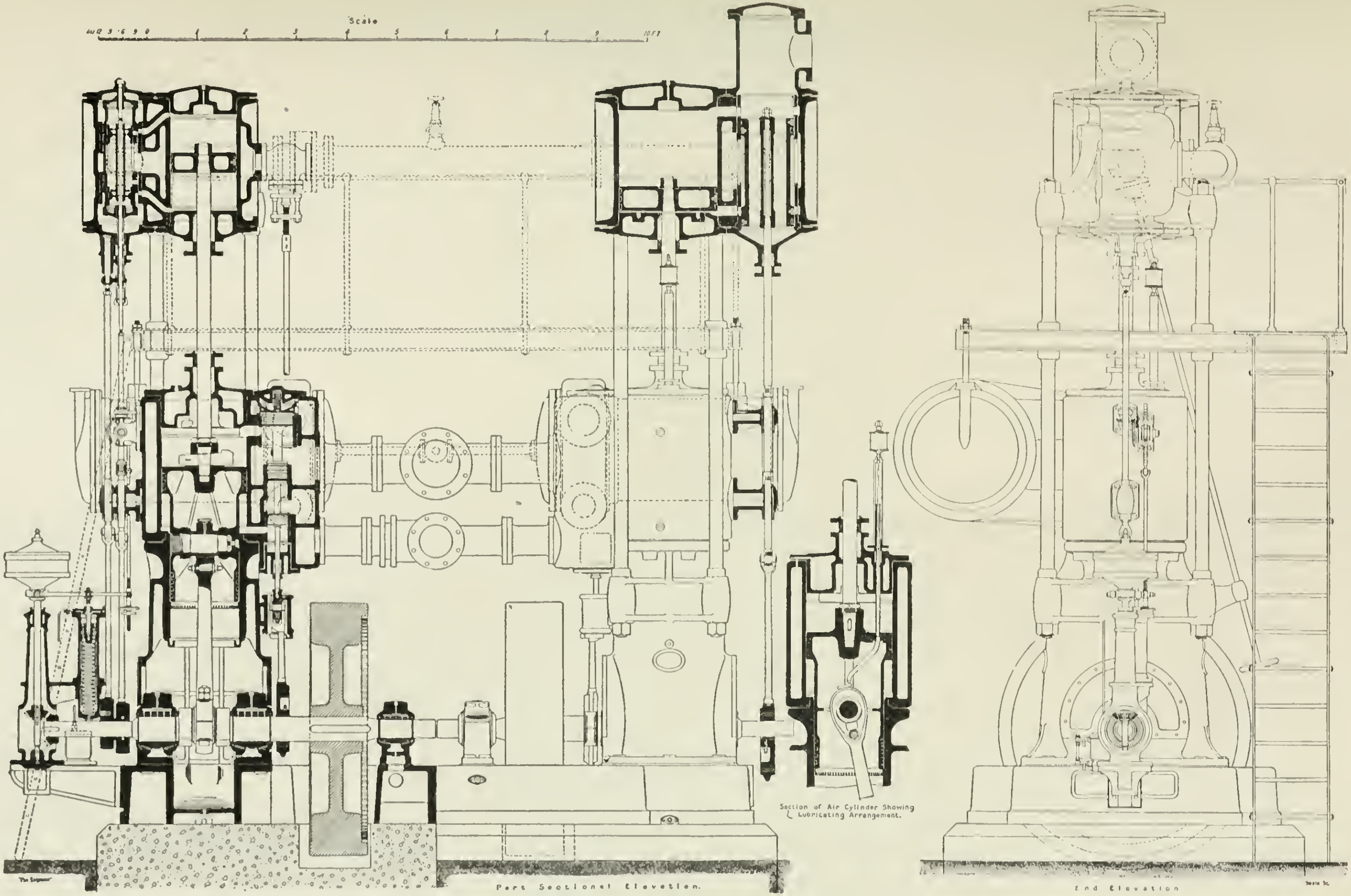
While the steam cylinders are, of course, removable, the air cylinders also can be entirely removed without disturbing the steam cylinders. Both the steam and the air cylinders have piston valves. The point of cut-off for the steam to the high pressure cylinder is governed by a combination of the running speed and the air pressure, and it can be adjusted while the machine is running by a variable expansion gear.

There is a separate eccentric for each steam and each air cylinder. Free air is drawn into the space on top of the differential compressor piston through the upper port, the piston valve being above the port at the time. When the air piston arrives at the end of its stroke the piston valve in descending closes the top port, and on the return stroke the air drawn



CROSS COMPOUND STEAM AND TWO STAGE AIR COMPRESSOR.

in as above mentioned is compressed on the up-stroke of the large piston to about 27 lb. per square inch. The piston valve then descends, and the top port is uncovered to allow the compressed air to flow past the spring valve at the top to the intercooler. This concludes the first stage of the operation. The air next passes from the intercooler to the suction side of the small high-pressure end of the piston, which is an annular space representing the difference in the diameters. When the piston descends, the second and final stage of compression to 100 lb. per square inch is effected. A movement of the piston valve next allows the compressed air to be discharged into the delivery pipe. There are three fixed points in the compression cycle, namely, the opening of the inlet, the closing of the inlet, and the closing of the discharge, which are positively and mechanically controlled. The opening of the discharge, which is the only variable point in the cycle, is controlled by an automatic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Section of Air Cylinder Showing
℄ Lubricating Arrangement.
End Elevation

VERTICAL SECTION AND END ELEVATION OF COMPRESSOR.

spring valve, which, however, is relieved of the necessity of quick and therefore noisy closing. During the suction stroke of either piston, the lower or the upper valve occupies the space between the cylinder port and the spring valve, reducing clearance to a minimum by discharging the compressed air left in the space through the delivery valves. The makers claim that the proportions of the cylinders are such that the load is equal for both strokes. Computations based upon the mean effective pressures in the air cylinders make the work for the down-stroke much the greater, but this is compensated for by the unbalanced weight of the reciprocating parts. The bearings and connecting-rodends are lubricated by means of a pump, which circulates the oil, and the crosshead of the differential air piston on each side is oiled by the special telescopic pipe fitted in the cover of the cylinder, as shown in the detail sectional view in the cut.

This compressor was for some reason built to metrical measurements, the following being the principal dimensions:

H. P. steam cylinder....400 mm. dia.
L. P. steam cylinder....600 mm. dia.
Differential air pistons..515 and 415 mm. dia.
Stroke ....450 mm.
Capacity, 950 cubic feet of free air per minute when running at 155 revs. per min.
Volumetric efficiency ...93 to 96 per cent.
Mechanical efficiency ...88 per cent.

AIR BRAKE PUMP EXHAUST CHANGE

On all locomotives the air brake pumps are operated by steam, and it has been the practice to conduct the exhaust steam from the pumps to the smoke box, to which the stack is attached, and then to release, causing a draft, the use of the main exhaust in the same way being an important function, when traction power is required. Considerable work is done by the brake pumps when the locomotive is at a standstill or when the train is running down grade, the steam then used often saving the safety valves from blowing off, while any increase of draft under those conditions is, of course, wasteful of fuel. On one hundred and fifty locomotives of the Lehigh Valley Railroad the brake pump exhaust has recently been changed to deliver outside instead of inside the smokestack. Tests show that the company is saving about 1,000 pounds of coal per locomotive on the descent of the grade from Glen Summit to Penn Haven Junction, twenty-six miles.

CONCRETE SHAFTS THROUGH QUICKSAND*

SMITH SHAFT.

The Cleveland-Cliffs Iron Mining Co., in the spring of 1907, made preparations to sink a timber drop shaft, near Princeton, Mich., and knowing the ground to be saturated with water, it was thought advisable to make a few tests. Several 6-inch pipes perforated most of their length were sunk a number of feet into the ground at the proposed site of the shaft, and two special Cameron pumps were connected to some of these pipes. Pumping was then started and continued for some time, a careful observation being exercised on the height of the water in one of the pipes which was not connected to the pumps but was left open for this purpose. Continuous pumping lowered the level of the water so little that the mining company concluded that it would be a difficult operation to sink a shaft by the ordinary drop-shaft methods, and a contract was entered into with the Foundation Company, of New York, for a reinforced-concrete shaft of rectangular cross-section, 15 ft. 4 in. × 11 ft. 4 in. The Company decided to use the pneumatic caisson, or compressed-air system, in sinking this shaft.

Plans were submitted and accepted by the mining compnay for a reinforced-concrete shaft. The specifications required principally that the shaft should be carried down plumb and water-tight, and that when the ledge was reached a water-tight joint should be effected between the shaft and the ledge, and the contract allowed 90 days for completion.

In dimensions the shaft was 21 ft. 4 in. × 17 ft. 4 in. outside, with walls 3 feet in thickness at the bottom and 1 ft. 6 in. at the top, and the concrete was started on top of a timber shoe or cutting edge which consisted of two layers of 12 in. × 12 in. fir timber, beveled on the inside, the bottom stick being shod with a heavy angle bar, the whole being strongly bolted horizontally and vertically, tying all the timber firmly together. The walls were of concrete strongly reinforced with 1¼-inch and 1-inch square steel bars spaced 6 inches to 8 inches vertically and about 18 inches horizontally. The horizontal reinforcement was designed to take the earth and water pressures, while the vertical rods mainly prevented the lower sections of the walls from pulling away from those above during sinking operations. These vertical rods passed down through the timber cutting edge, anchoring same to the concrete walls. Six feet above this cutting edge, and notched into the concrete wall, was the deck, or roof, of what is familiarly called the working chamber. It is of course necessary in using the pneumatic process to confine the air to make its use effective. This is accomplished in shaft work by building a roof or cover over the inside of the shaft, strong enough to withstand and hold any required air pressure. This roof, or deck, as it is technically called, may be located at a point near the bottom of the shaft or higher up as convenience may dictate.

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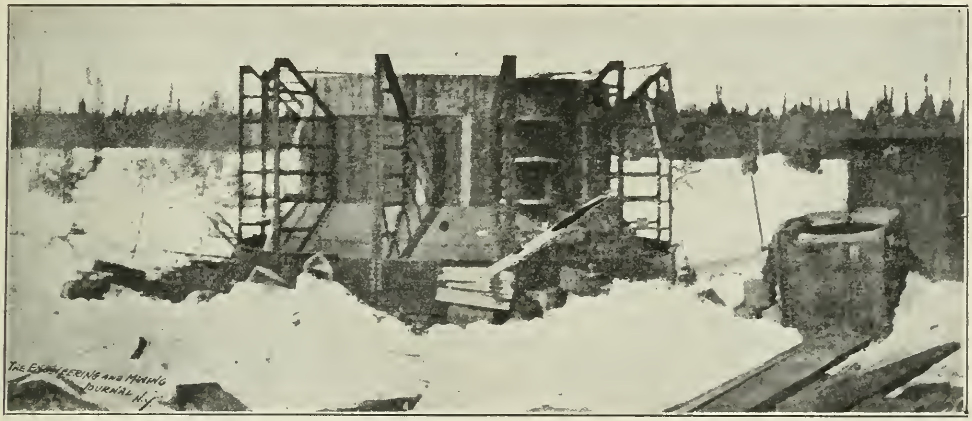
*Condensed from a paper by Frederick W. Adgate, Chicago, Ill., before the Lake Superior Mining Institute.



CIRCULAR CAISSON WITH CUTTING EDGE IN COURSE OF CONSTRUCTION.

After the shaft was on the ledge and a tight joint made with the ledge, the air pressure was removed, and then, owing to the manner in which the deck was notched into the walls, it was readily pulled out, and the notch concreted flush with the walls.

In the center of the shaft and bolted on to the upper side of the deck was the man-and-material shafting, which consisted of steel sections ½ in. × 48 in. diameter bolted together and supplied with vertical ladders bolted to the inside and extending from the deck to the surface of the ground. The 48-inch steel cylinder was surrounded by the Moran air lock, which was devised and patented by D. E. Moran, of the Foundation Company. A hole 3 feet in diameter was cut in the timber deck, which established a communication between the working chamber below the deck to the man-and-material shafting above the deck.

The cutting edge was first assembled at the surface of the ground and the inside forms for the first 10 feet built on top. All other forms were built apart from the shaft in sections 6 feet high and of interchangeable design. The form material was 2" × 8" tongued-and-grooved plank. After the forms had been placed and concreted to a height of about 18 feet, sinking without air was resorted to until water was encountered, at a depth of about 5 feet from the surface. Air was then pumped into the working chamber until the water had been displaced after which men were sent into the shaft. and excavating began. The material was shoveled into a bucket, hoisted up through the man-and-material shaft to the air lock; the contents dumped into small cars and removed some distance from the shaft where it was used to level up the ground. The bucket was returned to the working chamber for another load. On account of the slow-setting qualities of the cement, only one gang of men was required to excavate from 4 p. m to 12 o'clock midnight, in order to keep pace with the erection of the concrete which was carried on during the day.

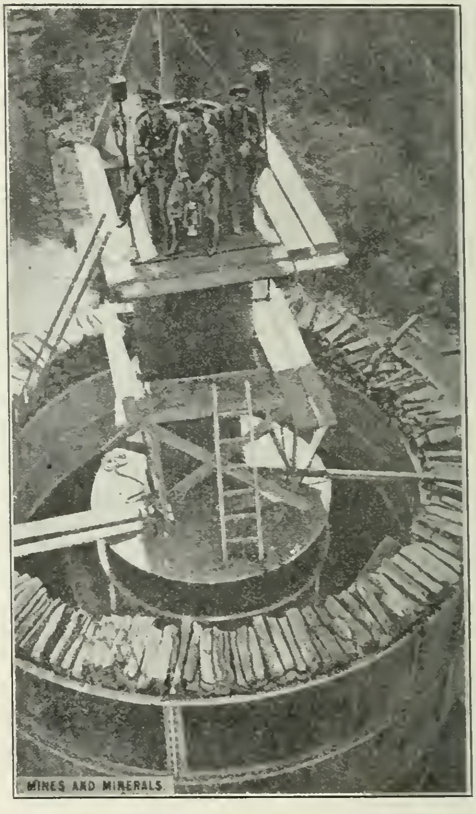
To keep the shaft lining above the ground at least 18 feet all the time, required the use of three sets of concrete forms, the lower set being removed as it reached the ground, and replaced at the top as the material was removed from the interior of the shaft and from under the cutting edge. The shaft sank of its own weight until it had reached a depth of approximately 40 feet when it became necessary to apply additional weight. The only available weight at that time was wet sand. This was loaded upon the deck in the interior of the shaft and increased from time to time. The shaft went down steadily until it reached solid rock on December 7, exactly 1 month from the time air was first applied. The rock was first encountered in one corner of the shaft and proved to have a slope of 3 feet 6 inches in 20 feet, and in order to make a water-tight joint, it was necessary to level off this rock and then go down about 2 feet further in order to get below a seam in the rock. The rock excavation was accomplished under air pressure; blasting was resorted to as in ordinary open excavations.

The rock excavation was completed January 5, 1908. The inside top timber comprising part of the cutting edge was then removed and the walls concreted to the rock, thus presenting a solid masonry face from ledge to surface. This joint was tied to the rock ledge with steel dowels and to the walls above by means of bolts projecting and which had previously held that part of the cutting edge which was removed and replaced by concrete. Air pressure was maintained on the shaft for 3 days after the completion of the joint to allow the concrete forming the joint ample time to set before subjecting it to the outside water pressure. The air pressure was then gradually reduced to zero. Subsequent inspections showed that the shaft developed a leakage of about 6 inches of water (650 gallons) in 24 hours, most of it coming through the rock ledge at the bottom, some little percolating along the wires in the walls above, which had been used to hold the concrete forms together. Absolutely no water, not even a seepage, was discernible through the joint. This was all that could be anticipated or hoped for, and I have since been informed that most of the leaks have dried up.

After sinking operations were completed, and the temporary weight of wet sand together with the deck was removed, holes were drilled into the walls and heavy cast-iron brackets bolted against the same. These brackets carry horizontal channel irons dividing the shaft into compartments for skips, cage, and a pipe and ladderway. It is further proposed to sheath these compartments with corrugated iron or similar fireproof material.

KIDDER SHAFT.

After the successful completion of the Smith shaft, the Cleveland-Cliffs Iron Co., entered into another contract with the Foundation Company to sink the Kidder shaft which is located in the same district. Here the conditions are somewhat different. The general character of the overburden is the same, but deeper, and the foundation rock is more broken up and seamy. It was decided that a circular shaft was best adapted to this particular site.



TOP OF KIDDER SHAPE CAISSON.

Plans were accordingly drawn for a reinforced concrete structure of a circular cross-section, being 24 feet in outside diameter and having an inside diameter large enough to provide a rectangular space of 14 ft. 10 in. × 10 ft. 10 in. The walls of the shaft were built upon a steel shoe, 24 feet outside diameter, where it was riveted to a steel cone plate on the inside, the slope of which extends up to a height of 10 feet, making the working chamber, or caisson, conical in shape and providing a circular opening at the top of the chamber, or cone, of a diameter of 10 feet, to the top of which are bolted steel sections of 10-foot diameter, which are carried up section by section as the structure sinks, and through which was operated a clam-shell dredge. This dredging cylinder also acted as a wall of the caisson while sinking operations were conducted by the pneumatic process.

The general plan of sinking the Kidder shaft was as follows: The shaft was erected some 15 feet in height and two sections of the dredging cylinder connected to the top of cone plates; a clam-shell dredge was then lowered through the 10-foot dredging shaft into the bottom where digging operations began. As the clam shell displaced the material, the shaft settled by its own weight. Care had to be taken to build on the top fast enough to always keep the top of the structure several feet above the surface. This plan of sinking was followed until the shaft had reached a depth of 87 feet below the surface, where a stratum of very hard clay was discovered which the dredge refused to handle. A steel deck or roof was then bolted on to the top of the dredging shaft. This deck in turn supported a Moran air lock and the shaft was now equipped for compressed-air operations which were immediately begun and the shaft carried down to the ledge which was found to be 104 feet from the surface. The ledge was so broken up and seamy that it was found necessary to take the shaft 9 feet into the ledge, making a total excavation of 113 feet from the bottom to the collar of the shaft, or 113 feet below water elevation.

The cutting edge or shoe, the inside of which forms the conical space at the bottom of the shaft, deserves further mention. It weighs approximately 40,000 pounds and is made in three horizontal sections, and each section is made up of 12 plates of ½-inch steel, joined to the succeeding section by a lap-riveted joint. On the outside of the bottom, there is a steel plate 30 inches high by ⅝ inch thick that forms the base of the cylinder and the outside form of the wall of the shaft to which the steel brackets and plates which form the cone are attached. The angle, or slope of the cone on the inside, with the outside of the shaft is made the shape of the brackets. This slope is the ratio of 7 to 10, or about 40 degrees, with the vertical or sides of the shaft. These brackets are riveted to the heavy outside plate and to all the plates forming the cone. There are 12 of these brackets and they are made in two parts bolted together, so that one part is readily detachable from that part of the steel work which necessarily remains in the concrete and forms part of the permanent wall. In the construction of the walls of the shaft, two sets of forms were used, one on the outside and one on the inside. The outside form is made of three sections 5 feet high and 24 feet in diameter. Each section is in turn made up of six plates of ½-inch steel bent to a 12-foot radius on the inside, on all four sides of these plates 4-inch angles are riveted to make the necessary connections of the several pieces to make the circle and also to connect the sections one to the other to make the wall continuous, proper bolt holes being punched at certain intervals in the angles to make this possible. The inside forms were also made in three sections, each section being constructed from 2 in. × 6 in. tongued-and-grooved pine held together by three sets of 4 in. × 4 in. × ½ in. angles bent to the radius that will give the necessary thickness of the wall at the various depths of the shaft.

The thickness of the walls of the shaft varies, of course, with the depth the shaft has to go and the pressures that will come on the wall. In the case of the Kidder shaft, the wall at the top is 2 feet thick, down to a depth of 17 feet. It is there increased to a 2′ 6″ wall, to a depth of 50 feet, then increased to a 3-foot wall at this point and carried to a depth of 82 feet and is there increased to a 3′ 6″ wall and carried with that thickness to the bottom, 113 feet below the surface.

In order to sink the Kidder shaft to the depth it finally went, it was necessary to use 375 tons of pig iron in order to overcome the excess of friction encountered and the upward pressure of the compressed air over and above the weight of the structure itself.

At a point 87 feet below the surface, a very hard stratum of clay some 2 feet thick was discovered. After dredging some hours without much success the clay was penetrated at one point only and the quicksand which underlies the stratum of clay started to run into the interior of the shaft, causing a run-in or slump of the ground on the outside of the shaft at one point only, which extended to the surface and threw the shaft some 6 inches out of plumb. Dredging was then abandoned and the shaft equipped to carry on further sinking operations by the pneumatic process. This method was used until the completion of the shaft. When the shaft had been sunk into the ledge some 9 feet a concrete joint was constructed similar to that described in the Smith shaft.

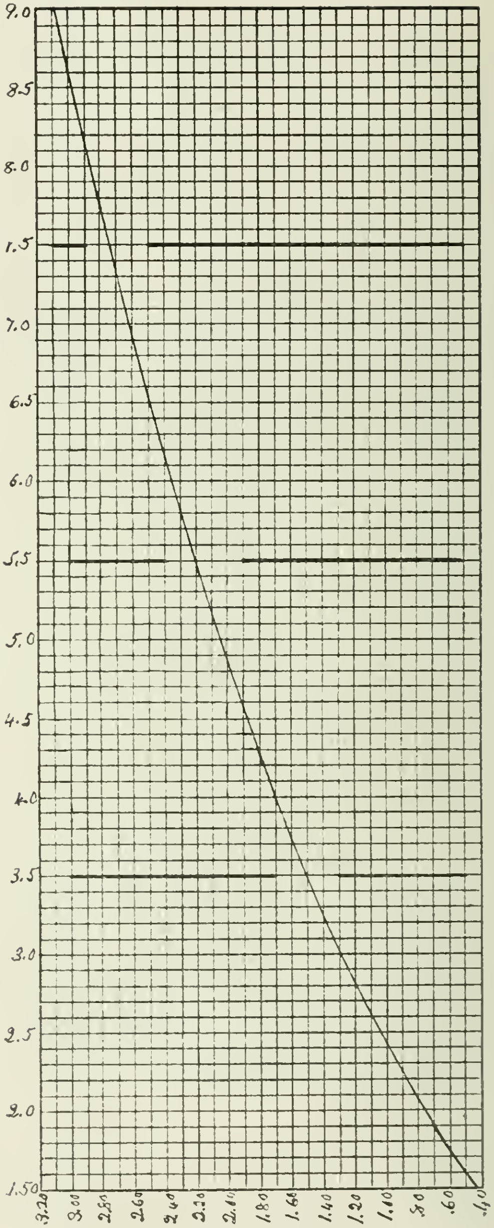
The maximum air pressure used on the Kidder shaft was 45 pounds above atmosphere. This is about the limit of human endurance and very dangerous to the men employed inside the shaft. At the greatest depth two shifts of 40 minutes each constituted a day's work, and while no fatal effects followed, three of the men are to-day suffering from partial paralysis and will never wholly recover from its effects.

MEAN EFFECTIVE PRESSURE IN AIR COMPRESSION

We reproduce on the opposite page, from a recent issue of the American Machinist, a diagram which, under all conditions which occur in the adibatic compression of air affords the simplest means yet devised, or we might say, likely to be devised, for ascertaining the mean effective pressure in the cylinder for the entire operation, and from that, of course, also the horse power. The diagram was calculated and plotted by Mr. Ward Raymond, assistant chief engineer at the Phillipsburg plant of the Ingersoll-Rand Company.

The diagram is, of course, immediately and clearly intelligible to the trained engineer and to the well informed student, but we think that a word or two of explanation more than was given with the original publication of the diagram may make it available to a still larger number who are normally more expert in other lines.

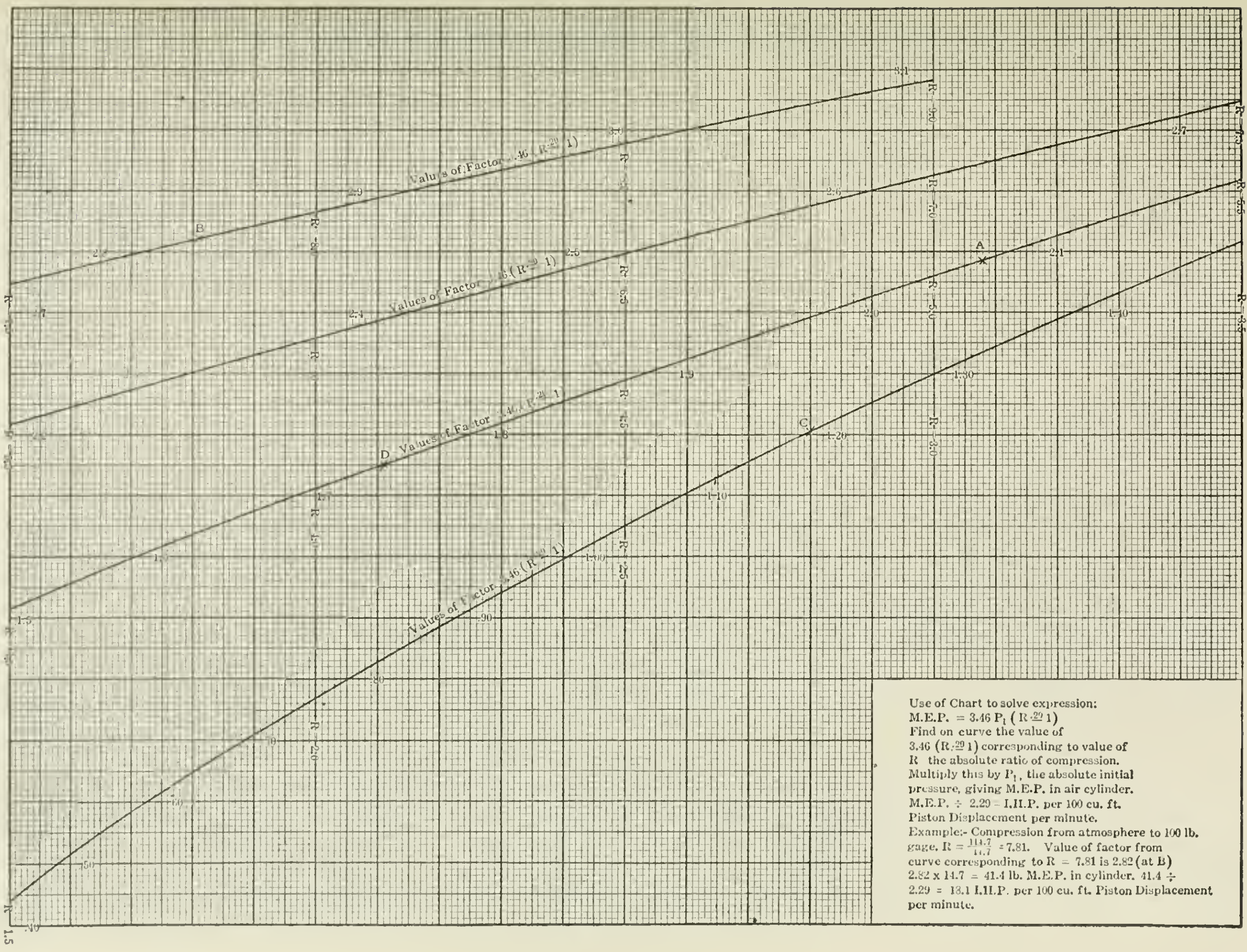
The four curves of the diagram are, in fact, four separate portions of a single curve brought together upon a single sheet for compactness in publication rather than for convenience in use. The entire curve is shown on a much smaller scale in Fig. 1. The section lines in this cut correspond to the larger section lines only of the other diagram. In this cut all the figures indicating the lines are in regular sequence. In the large diagram the figures belong only to the curve nearest which they are located, and do not apply in any way to more than the one curve.



THE ENTIRE CURVE.

The diagram embodies the solution of the expression:

$$M E P = 3.46 P_1 (R^{0.29} - 1).$$



Use of Chart to solve expression:
M.E.P. = 3.46 P_1 ($R^{.29}-1$)
Find on curve the value of
3.46 ($R^{.29}-1$) corresponding to value of
R the absolute ratio of compression.
Multiply this by P_1, the absolute initial
pressure, giving M.E.P. in air cylinder.
M.E.P. ÷ 2.29 = I.H.P. per 100 cu. ft.
Piston Displacement per minute.
Example:- Compression from atmosphere to 100 lb.
gage. $R = \frac{114.7}{14.7} = 7.81$. Value of factor from
curve corresponding to R = 7.81 is 2.82 (at B)
2.82 x 14.7 = 41.4 lb. M.E.P. in cylinder. 41.4 ÷
2.29 = 18.1 I.H.P. per 100 cu. ft. Piston Displacement
per minute.

WARD RAYMOND'S CHART FOR DERIVING MEAN EFFECTIVE PRESSURES FOR ADIABATIC COMPRESSION OF AIR FROM ANY INTAKE PRESSURE

M E P refers to mean effective pressure developed in the air cylinder; P_1 is the absolute initial pressure, which in the case of an air compressor is usually atmospheric; R is the ratio of compression, or the absolute discharge pressure divided by the absolute initial pressure. Knowing the value of R from the conditions of the problem, we find directly from the diagram the corresponding value of the rest of the expression, namely, $3.46\ (R^{0.29} - 1)$, and multiplying this factor by the absolute initial pressure, gives at once the mean effective pressure. The four following examples will serve to show the simplicity of the operation:

1. Assume single-stage compression from the atmosphere to 60 pounds gage pressure. R, the ratio of compression, will be $(60 + 14.7) \div 14.7$, or $74.7 \div 14.7 = 5.08$. Examining the diagram we find that the vertical line marked A contains the value of $R = 5.08$. From the curve at this point we find that the value of the factor for which we are looking is 2.082. In the case of this problem the initial pressure is atmospheric, or 14.7 pounds per square inch absolute. Multiplying 2.082 by 14.7 we have a mean effective pressure developed in the air-compressor cylinder of 30.6 pounds per square inch, based on adiabatic compression. This is the true theoretical adiabatic *M E P* exerted against the piston and it is not necessary to deduct the back pressure from this as in the case of the usual steam formula.

In most compressed-air problems the mean effective pressure is not wanted so often as the indicated horsepower per 100 cubic feet piston displacement per minute, and in all cases this can be found by dividing the mean effective pressure by 2.29. For the case in point, dividing 30.6 by 2.29, we have 13.4 indicated horsepower developed in the air cylinder per 100 cubic feet of piston displacement per minute. Dividing this by 100 and multiplying by the piston displacement per minute of the compressor, we have the total indicated horsepower in the air cylinder in question.

Say that the compressor cylinder was 24 in. diameter by 30 in. stroke at 60 revolutions per minute; then the free air capacity would be:

$24^2 + 7854 + 5 + 60 \div 144 = 942$ cu. ft. per min. Then $9.42 \times 13.4 = 126$ theoretical horsepower.

2. If the compression were single-stage from atmosphere to 100 pounds the value of R would be

$$114.7 \div 14.7 = 7.81.$$

From the diagram we find that the vertical line containing $R = 7.81$, crosses the line of the diagram at the point marked B, corresponding to a factor value of 2.82. Multiplying this factor by the initial pressure 14.7 pounds, absolute, we have an answer of 41.4 pounds per square inch *M E P* developed in the air cylinder. Again, dividing this by 2.29 we have 18.1 indicated horsepower developed per 100 cubic feet of piston displacement per minute.

3. For compound compression we have only to remember that with theoretical conditions the horsepower of the low-pressure and the high-pressure cylinders should be alike, giving the minimum total power developed. In practice air compressors are designed so that this is approximately true. The curves and all the formulas are, of course, based on theoretical adiabatic compression, and therefore we are correct in assuming that the horsepowers in each of the two stages of compression are equal. If the horsepowers are equal this means that the ratios of compression in the two stages also are equal, and consequently the ratio of compression in each cylinder for compound compression will be the square root of the total ratio of compression.

From atmosphere to 100 pounds pressure we have already found that the total ratio of compression is 7.81. The square root of this, or the ratio of compression in either the low-pressure or the high-pressure cylinder, is 2.8. Entering the diagram we find that the line corresponding to the value of $R = 2.8$ crosses the factor line in the diagram at the point marked C and corresponds to the value of the factor 1.204. Multiplying 1.204 by the initial pressure 14.7, we have the mean effective pressure in the low-pressure cylinder 17.7 pounds per square inch. Dividing 17.7 by 2.29, we have the power in the low-pressure cylinder, 7.73 indicated horsepower per 100 cubic feet of displacement of this low-pressure cylinder. As this must be half of the total compressor horsepower of the compound compression, we have 15.46 indicated horsepower total for the two stages per 100 cubic feet of displacement per minute. Dividing this by 100 and multiplying by the low-pressure cylinder displacement in cubic feet per minute we would have the total indicated horsepower of the compressor in question.

This process may be carried through three, four, five or any number of stages of compression. All that needs to be remembered is that for multiple-stage compression the horsepower in all the cylinders is supposed to be equal; therefore finding the horsepower in the low-pressure cylinder we can multiply this by the number of stages or cylinders, giving us the total horsepower of the compressor. In order that the horsepowers shall be equal, the ratios of compression in the various stages must be equal and consequently for compound compression, must be equal to the square root; for three-stage the cube root and for four-stage the fourth root of the total ratio of compression.

4. Assume three-stage compression to 1000 pounds pressure. The value of R, the ratio of compression, will be 1014.7 divided by 14.7 or 69.2 compressions. With equal horsepower in each stage the ratio of compression in each stage and consequently in the low-pressure cylinder, will be the cube root of 69.2, or 4.11, and in the diagram we have the value of 4.11 for R marked D. For this value of R the diagram gives us the factor 1.75. Multiplying 1.75 by 14.7 we have 25.7 pounds per square inch mean effective pressure in the low-pressure cylinder. Dividing this by 2.29 we have 11.22 indicated horsepower per 100 cubic feet per minute displacement of the low-pressure cylinder.

This is the horsepower in the first stage, also in each of the succeeding stages; consequently multiplying this figure by the number of stages, namely, three, we have a total horsepower for the compressor of 33.7 indicated horsepower per 100 cubic feet piston displacement of the low-pressure cylinder of the compressor per minute. This divided by 100 and multiplied by the piston displacement of the low-pressure cylinder per minute will give the total theoretical horsepower of the compressor.

METHANE FROM COAL SEAMS AS FUEL

Information respecting a very interesting utilization of the dreaded explosive hydrocarbon of coal seams, methane CH_4, has recently become available from the Frankenholz Colliery of the Frankenholz Bergwerks-Gesellschaft, near Mittelbesebach, in Rhenish Bavaria. The mine has a depth of 500 metres, and before attacking the coal seam at that level it was deemed advisable to bore to a depth of 50 metres in order to see whether much gas might have to be dealt with. When this was done a great deal of gas escaped under considerable pressure, and a pipe-line of 1,500 metres length (nearly 1 mile) was taken up to the surface. This was in February, last year. As the pressure of the gas was still 12 atmospheres in June, 1908, the Dingler Maschinenfabrik A. G., of Zweibrücken, was asked to fit the Lancashire boilers of the colliery for burning this methane. In order not to waste any of the heating surface of the two internal furnaces, and to secure a complete combustion of the methane, the following arrangement has been adopted.

Two combustion chambers, consisting of two cylinders placed alongside one another, have been constructed in front of the boiler, each chamber communicating through a neck of smaller diameter than the combustion chamber with the internal furnace. The gas is introduced through the front of the cylinder by a central pipe, inside which a small air-pipe has been provided. The main air feed is, however, through a crescent-shaped inlet, closed by an adjustable slide. The front of the chamber is further fitted with a door; through this door a torch is introduced before the gas admission valve is opened, lest any explosive mixture collect in the internal furnace. The combustion chambers are built of firebrick, and a layer of asbestos is interposed between the outside of the firebrick and the cylindrical iron shell. The gas is very fairly pure methane, containing about 8 per cent. of nitrogen, traces of oxygen, and some water vapor. As far as possible this vapor is condensed in the pipe-line of 6 1-2 in. internal diameter, which is for this purpose provided with cylindrical condensers. Two methane boreholes supply sufficient gas for two boilers, each of 700 square feet heating surface, and 40 kilogrammes of steam are produced per square centimetre of heating surface per hour (about 9 lb. per square foot.) The temperature of the flue gases leaving the boiler furnace does not exceed 280 deg. Cent. (530 deg. Fahr.) We have not yet received any exact determination of the gas consumption; but it is estimated that the methane burned is calorically equivalent to about 16 tons of average quality coal per 24 hours. We understand that it is intended to resort to further boring, with the object both of increasing the safety of the mine and of utilising the methane gas. In several of our mines the escaping methane is used for illumination; but we are not aware of any case of burning the gas for the purpose of generating steam.

HOMEMADE PRESSURE REGULATOR

The pressure regulator described herewith was designed to regulate a compressed-air oiling system, but by using heavy glass and brass connections the instrument can be used on higher pressures.

The regulator consists of a U-shaped glass tube ⅛ inch in diameter. Glass cups are fitted on the ends, as shown. As fusing a wire into a glass tube requires platinum wire and, no little patience, I made the cup connections very secure with corks and wax, as the drawing shows. This makes the ends the strongest part of the cups. Two No. 20 rubber-insulated copper wires are inserted through holes in the cups, and sealed in after being adjusted to the desired pressure and cut to the same length. Each wire must be scraped bright ⅛ inch on the end.

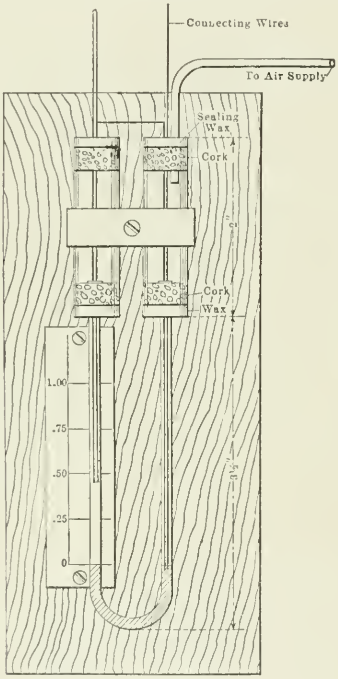


FIG. 1. PRESSURE REGULATOR.

A brass tube also enters the top of the right-hand cup and is connected to the air space in the oil reservoir. In the regulator which I made, a valve was placed just above the cup, a nipple connecting the cup and valve.

Fig. 2 shows the electrical connections, which run to a solenoid *O*. The solenoid was taken from an old arc lamp, and has considerable lifting power. If the screw on the back of the stop cock *S* is loosened and the valve well oiled, no trouble will be experienced in making the solenoid operate the cock. A trip magnet *M* allows the arm *A* to fall and cut off the air supply when the circuit at the regulator is closed.

A glance at the diagram will show the principle of operation; a rise of pressure above a certain value forces the mercury up in the left-hand tube, closing the circuit *X* and shutting off the air supply. A drop in pressure will cause circuit Y to energize the solenoid, opening the air valve. A little oil on the mercury surfaces will prevent sparking.

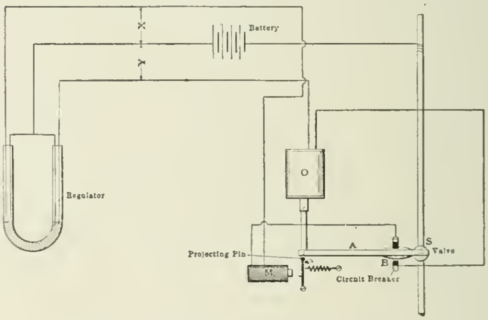


FIG. 2. REGULATOR AND CONNECTIONS.

On high pressures the left-hand cup must be sealed at the top; on low pressures the top may be left open and the scale calibrated as follows: Open both ends of the tube to the atmosphere and, taking the mercury level as zero, make divisions 1 inch apart; each division then represents approximately 1 pound per square inch. For feet of water the divisions should be 7/16 inch apart, each division representing 1 foot of water.

The easiest way to make a cut-out switch that will open the circuit as soon as the valve changes is to fasten a blade of copper *B* to the arm *A*. Then the current cannot be restored until contact is made on the opposite side.

In case the apparatus is used for a water-tank regulator, the scale divisions may be made 4/5 inch apart, each division representing one foot of water. For this use it is better to make the U-tube 18 inches or more in length.—*R. S. Seese in Power and the Engineer.*

HUMID AIR TROUBLE IN A STEAM HEATING SYSTEM

BY A. J. DIXON.

The heating system in a populously tenanted public building had become an unremitting source of exasperation, alike to those occupying quarters in the building and to the engineer and attendants in charge of the apparatus, on account of its ever-present propensity to get out of order and refuse to properly perform its function in a dozen or more different and widely separated places at the same time. A prominent feature of this heating outfit comprised an equipment of thermostats for automatically regulating the admission of steam to the various radiators and heating coils, the controlling medium being air compressed to about 15 pounds gage per square inch. The admission of this compressed air to impingement upon the diaphragms by which the steam valves were actuated, and its release therefrom, was controlled by somewhat complicated mechanism under the immediate influence of the theromostats, and to the everlasting proneness of these contrivances to become inoperative, by reason of the moisture in the saturated air fouling and obstructing the minute ports and passages therein, was generally due the failure of the heating apparatus.

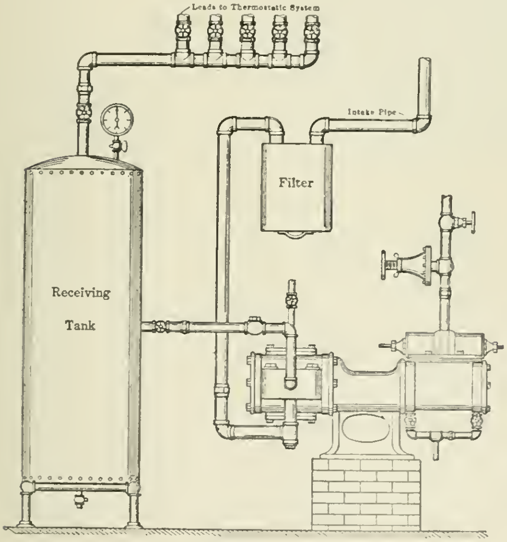


FIG. 1.

The equipment for compressing and storing the air, and its manner of distribution, as planned in the original imstallation, is shown in Fig. 1. The presence of an excessive quantity of moisture in the air flowing through the five leads to the various branches of the system furnished ample evidence of the fact that but a very small percentage of the water, with which the air passing through the intake pipe was laden, was being precipitated in the receiving tank, and likewise made it plainly apparent that a more adequate means for disposing of this moisture would have to be provided before the thermostatic system could be depended upon to properly regulate the temperature of the building. The engineer in charge of the plant, therefore, cast about for an available method for improving the situation, and after pondering various schemes that were advanced, he finally hit upon the device illustrated in Fig. 2.

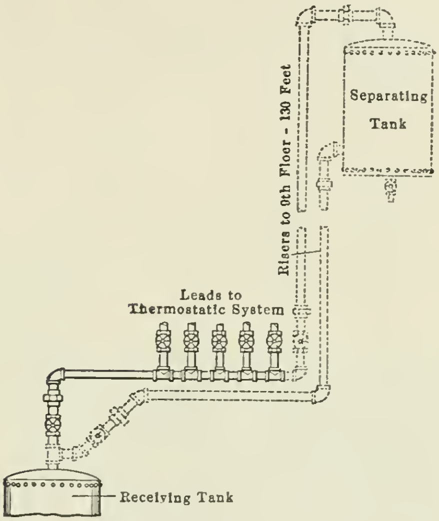
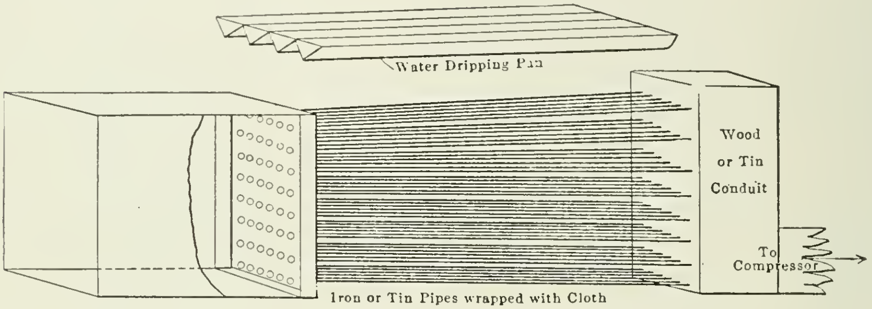


FIG. 2.

A tee was inserted in the short riser from the main reservoir, and a 1½-inch branch and riser was carried therefrom to a vertical hight of 130 feet, where it connected with a precipitating tank located upon one of the upper floors. The object aimed at in conveying the air to this hight above the plane of distribution was to provide ample opportunity for the entrained moisture to separate by gravitation from the column of air in its ascension through the long vertical passage, the supposition being that the precipitation produced in this manner, combined with the final separation effected in the upper tank, would result in eliminating the water vapor to such an extent as to provide a practically dry supply of air. Subsequent events proved this surmise to be eminently correct, for after the installation of the contrivance shown in the sketch no further trouble was experienced.—*Power and the Engineer.*

cloths constantly wet. There should be no enclosure and no obstruction to a free circulation of air, and if winds or drafts can be enticed to play upon the tubes, so much the better.

It is suggested, as bearing upon the practical value of precooling, that at a large plant in California the difference between the temperatures of wet and dry thermometers in summer has reached 40 degrees, or between 110 and 70, this being in absolute temperatures, and consequently in air volumes nearly 8 per cent. cent.



AN AIR COMPRESSOR PRECOOLER

It is, of course, well understood that when a certain weight or quantity of air is to be compressed any reduction of its volume by the lowering of its temperature before it enters the compressor cylinder effects a saving in direct proportion. Wherever it is possible to materially reduce the temperature of the intake air it can usually be done without appreciable cost beyond the installation of the cooling apparatus, and the economical results secured come as near to the getting of something for nothing as can be expected in mechanical practice.

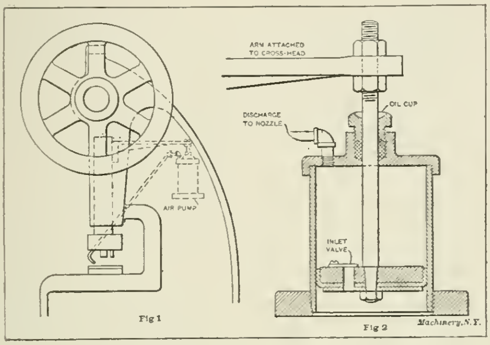
The sketch which we here reproduce from a recent issue of the Engineering and Mining Journal, shows a precooler arrangement which should be effective and satisfactory where it can be employed. The cooling tubes, as they are not subjected to pressure either external or internal, and as the thinner they are the better, may be made of any odd sizes of iron, or even tin or galvanized iron speaking tubes may be used. These should be wrapped with thin cloths and perforations in the water dripping pan above should be sufficient to keep the cloths constantly wet.

In the remarks of our contemporary in connection with the present precooler, it is said: "It is to be emphasized in the beginning that water or moist air should have no chance to mix with the compressor suction. . . . The arrangement shown in the sketch precludes the saturation of the air with water, as recently complained of in South Africa, where precooling by spraying water directly into the intake was attempted. In fact, if the temperature of the water supply is below the dew point, and an abundance is available, water will actually be condensed out of the air as drawn to the compressor, and can be drawn off from the bottom of the cool air conduit."

This means, of course, that the air cooled without contact with water may be and often is completely saturated with moisture as it enters the compressor, so that it may be unobjectionable and often good practice to wash and cool the air by water in intimate contact with it. As air after compression and recooling to normal temperature is practically always supersaturated with moisture, it is futile to attempt to get or to keep the air "dry" before the compression.

A PRESS DOES ITS OWN BLOWING

In our October issue, page 5436, we reproduced a cut from *Machinery* showing how the shop air pressure was employed to blow small pieces of work from a forming die in a punch press. The cut here shown, from the same publication, tells very clearly how another punch was equipped with a compressor or pump of its own. The piston rod of this pump is connected directly to the crosshead of the press. The air is compressed on the up stroke, and it is delivered against the work by means of ⅛-inch pipe which is fitted on the end with a nozzle. The pump cylinder is made of a piece of 3-inch brass tubing which is screwed into a base-plate, as shown in the enlarged sectional view, Fig. 2. This tubing is fitted with a head containing a stuffing box, and ⅛-inch pipe outlet. The piston is a regular 3-inch hydraulic cup, and a piece of leather belting is used as packing. A piece of leather fastened by one screw to the inside of the piston, covers a ⅜-inch hole and acts as an inlet valve. The finished work has an upturned portion on the front end, and the nozzle is placed so as to direct the blast against this point.



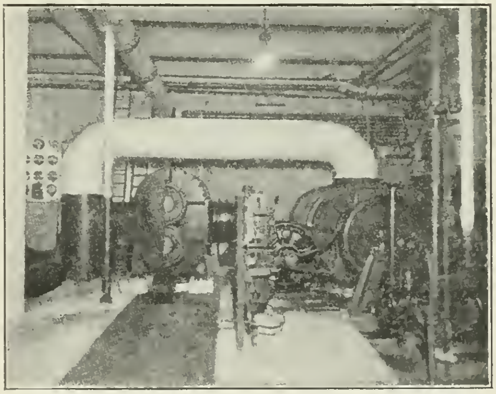
WORK BLOWER FOR PUNCH PRESS.

A DEPARTMENT STORE PNEUMATIC CASH SYSTEM

An interesting pneumatic cash system has recently been placed in operation in a large department store at Pittsburg. There is approximately seven acres of floor space and over three miles of cash tubing is in use. Change is made in an average time, for all stations, of from one to two minutes.

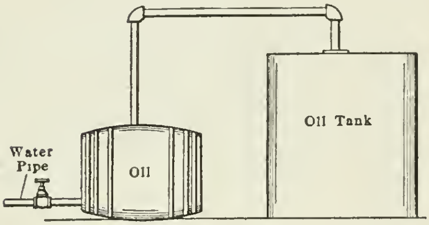
The system, which was installed by the Lamson Consolidated Store Service Company, is know as an independent vacuum pneumatic-tube system. There are eighty-four lines in operation, seventy-three of which are for cash and the remaining seven take care of the charges.

The cash office, is located in the basement, under about the center of the building. From eighteen to twenty-four cashiers, of whom four or five are at the charge desks, are employed to handle the business. Each cashier operates from five to seven lines, a space of about twelve inches separating the banks of tubes assigned the operators. The charge desks are located in the center of the cash office. The charge lines, or tubes, branch off from here to the various points, so located that there is one charge station between every two cashiers. This arrangement brings the regular cashier into close touch with those who enter the charges. The charge desks are also connected by tubes with the general offices on the fifth and the credit office on the first floor. Each of the eighty-four salesmen's stations uses, on an average, six cash and four charge carriers.



BLOWERS FOR CASH SYSTEM.

The power to operate this system is furnished by two Root Blowers, chain driven, by Western Electric fifty and fifty-five horsepower motors. The blower shown at the right in the accompanying illustration (from *Electrical Review and Western Electrician*) is the larger of the two. The plant includes also a vacuum cleaning system, a twenty ton refrigerating equipment and thirty-eight motors of various sizes. There is a special motor driven compressor which furnishes air to a stopcock and hose outside. Where automobile owners may pump up their tires—without the pumping.



WATER INSTEAD OF AIR FOR TRANSFERRING OIL

Our readers are sufficiently familiar with the use of compressed air for forcing liquids as in the emptying of oil barrels. The sketch by a correspondent of Power and the Engineer shows how water may sometimes be employed to advantage for this service. Connect a pipe into one head of the barrel near the lower edge, and another leading from the bung to the oil tank as shown. Then put the city water pressure on the pipe in the head which will force the oil into the tank. The oil, being lighter than the water, will keep on top until the last drop of it is forced out. The connections must, of course, be tight, although the pressure will not be great. This is after all not nearly as good as a compressed air apparatus, because it will not be easy to determine precisely when the oil is all out to stop the flow of water into the tank, and then also there will be the barrel of water to be disposed of.

A FOUNDRY PATTERN EXPLODES

Stahl and Eisen, in a recent issue describes an unusual, if not unheard of, accident. A large engine bed, molded in the floor, was being cast. The mold had been dried by torches. Its cores were vented upward, except those of the shaft bearing, whose vents were lateral. In addition, deep vent-holes had been pricked in the sand all around the periphery of the mold at short intervals, say, 4 ins. apart. Alongside this mold and about 5 ft. away, a second mold of this frame was in preparation, and the pattern was in the sand with no cope on it at the time. This pattern was substantially a long, hollow box, closed on all sides, about 22 ft. long by 2½ ft. wide and 4 ft. deep. About three hours after the finished mold was poured, some men were at work nearby filling a ladle with molten iron, and a drop of the iron was spattered out upon the top of the frame pattern lying in the unfinished mold. The pattern blew up violently, injuring five men, one fatally, damaging the roof and breaking most of the windows of the foundry. It seems that the venting of the frame mold had not been sufficient to carry all the gases off freely, and enough filtered through to the adjoining unfinished mold and through the joints of the pattern to fill its hollow interior with an explosive mixture. The same frame had been cast several times previously without accident, but after the explosion the top face of the pattern was provided with several large holes, to make impossible any accumulation of gas inside.

THE ITALIAN WIRE SAW FOR STONE

The elder Corsi, whose surname is Adolfo, is the marble magnate of Italy. The younger Corsi has recently visited the United States. The following is his account, from a reported interview in the New York *Sun,* of the Italian wire saw:

"The cutting machine invented by our engineers has revolutionized the marble industry of Italy. We have done away with the use of dynamite. The machine is simple, consisting of a cable about the size of a pencil which is composed of three strands and drums, which, of course, have to be operated by an engine. The cable, which acts as a saw, is kept running in one direction, its work being helped with applications of sand and water. For a length of a hundred feet it will cut six inches in an hour. All this work we used to do in Italy by hand. With the aid of the machine we have done work in the mountains within one week that used to take us two or three years. We once took out a block by this method that measured 250,000 cubic feet."

He further says, and we are not inclined to accept his dictum, that "We cannot use derricks in our quarries. We have to break up our undesirable stone as we go along and remove it by hand, consequently we are having frequent powder blasts, and derrick machinery would not stand a bombardment of rocks."

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
FRANK RICHARDS, - - Managing Editor
L. I. WIGHTMAN, - - - Business Manager
H. L. KEELY, - - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. JANUARY, 1910. No. 1

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UNCOMPARABLE RECORDS

In the race of life the pacemaker is always, though often unknowingly, an essential agent of progress. It helps and stimulates us to know not only what others have done and how they have done it, but also their rate of accomplishment. In any industrial operations, especially where, as always, speed and cheapness are to be considered, the record of the latest work done must be certainly not behind and should be in advance of all which has been done before. The making of records is not to be recognized as such except at it is also the breaking of records.

It is unfortunate, but still not infrequent, that records made are not properly or fairly comparable with those made by predecessors, or even by contemporary competitors, because the conditions of working are not the same in the different cases. In our present issue is an instance of the perfectly comparable record, in the performance of the locomotive rock drill as compared with the work of the tripod mounted, hand manipulated drills which it superseded, doing precisely the same class of work in identical material. So in driving a tunnel, if certain drills and mountings and methods of handling the material accomplished results which were accurately measured and recorded as to the quantity of rock removed or the lineal advance made in a given time, and if these drills and mountings with the system followed in the various correlated operations were so changed or modified as to show in the same tunnel and the same rock a much more rapid advance, then the work of the latter would be fairly demonstrated as superior. But this seldom or never happens. We have been making world records in tunnel driving in the past year or two and each successive increase in the figures has been widely and boastfully published, but unfortunately these have been made in different tunnels continents apart and with no reference to the kind of rock, the size of the tunnel, the personnel of the operating force, or any other responsible particular.

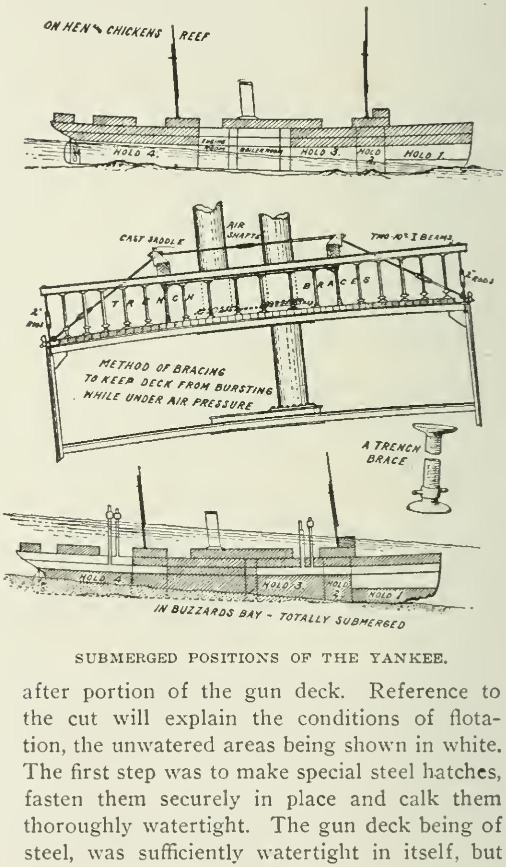
It is sufficient here to speak of only two now familiar tunnel driving records. The driving of the Loetschberg tunnel in Switzerland was described in our issue of February, 1909, page 5063. In this tunnel a record run of 1013 feet was made for the month of July, 1909. Reference to this is made by an esteemed contemporary in announcing "A World's Record in

Tunnel Driving" as having been made on the tunnel of the Los Angeles (Cal.) aqueduct in the 31 days of August, 1909, when an advance of 1061.6 feet was recorded. It is only necessary to say that the Loetschberg tunnel is driven in hard, solid rock requiring the most strenuous and constant pounding of the air operated rock drill and that the sectional area of the tunnel—for a two track railway—is 66 square yards. The section of the Los Angeles aqueduct is not more than one quarter of this and the material through which the record drive was made can scarcely be called rock at all. We are told that the drilling was all done by "hand drills," but these were not, as generally understood, air operated drills manipulated by hand, but simply coal augers worked by hand and run into the "rock" to depths up to 12 feet. Even the usual devices for ventilating the tunnel were not required, as this was taken care of by driving holes up through the roof of the tunnel to the surface, which was only about 75 feet. The absurdity of comparing this work with that of the Loetschberg tunnel is sufficiently evident, and if the record had doubled that of the Alpine tunnel it should not have surprised any one sufficiently informed as to the facts.

AN UNFORTUNATE YANKEE

In our issue of a year ago we briefly noted "The Ups and Downs of the Yankee." This U. S. auxiliary cruiser in September, 1908, was run upon Hen and Chickens Reef at the entrance to Buzzard's Bay, Mass., her position being indicated by the upper of the sketches here reproduced from the Scientific American. The bottom was pierced and torn in several places so that pumps were useless and a contract was awarded to Mr. John G. Arbuckle to raise her by means of compressed air. As in this case the vessel was not all under water, it was possible to place the necessary apparatus upon the vessel. The berth deck was made watertight and the water was driven down and out of holds 1, 2, 3 and 4 by compressed air, while the engine and boiler rooms were pumped out. The ship was floated by these means on December 4th, and was being towed to New Bedford when a tug struck her, damaging particularly the compartment containing the compressors, so that they could not be kept running and the vessel slowly sank in the position shown in the lower figure of the sketch. The bow of the vessel was a few feet below the water, but the stern lay thirty feet below the surface.

In the new salvage operations, divers being necessary all through, it was decided to leave the lower holds, the engine and boiler rooms, and the greater part of the gun deck full of water, and to lift the ship by expelling the water from the upper portion of hold No. 1, from the whole of the berth deck, and from the after portion of the gun deck. Reference to the cut will explain the conditions of flotation, the unwatered areas being shown in white. The first step was to make special steel hatches, fasten them securely in place and calk them thoroughly watertight. The gun deck being of steel, was sufficiently watertight in itself, but the after portion of the spar deck, being of wood and having comparatively little resisting strength against the upward pressure of the air, it became necessary to reinforce it strongly. This was done by placing above the spar deck and upon the deck house a series of 10-inch I beams arranged in pairs, which extended the full width of the vessel. At its outer ends each pair of beams was anchored down to the waterway at the side of the ship by 2-inch



SUBMERGED POSITIONS OF THE YANKEE.

iron rods set up with turnbuckles. Upon the beams, immediately over the side walls of the deck house, two 12 x 12 timbers were placed parallel with the axis of the ship. Upon the outer edges of these beams were set special cast-iron angle blocks, which were tied together with 2½-inch rods. From each angle block on each side of the deck house a pair of 1½-inch truss rods was carried down and made fast to eyebolts which passed through the side plating of the ship and were held in place by nuts. Between the under side of the I beam and the spar deck were placed a number of trench braces, which were set up until they bore snugly against the spar, thereby serving to transfer the upward pressure of the air to the system of trussed I beams as above described.

The special steel hatches were provided with openings to which were coupled five large steel airshafts, which extended above the surface of the water and were provided at their upper ends with air locks. The wrecking plant consists of a large schooner, which is fitted up with living accommodations for the men; a big wrecking steamer, upon which is installed a compressor plant capable of delivering 5,000 cubic feet of free air per minute; a number of ship's boats, and a steam tug which makes regular trips between New Bedford and the scene of the wreck, two miles out in Buzzard's Bay. The difficulties of the work were greatly enhanced by the exposed position of the wreck, and there were many days when it was impossible to do any work.

These remarkable salvage operatives made excellent progress. The sections of the ship to be unwatered having been made airtight, and the truss bridging over the spar deck completed, a favorable conjunction of wind and tide concurring, the compressed air occupied its allotted spaces and the Yankee rose to the surface almost exactly a year later than her previous flotation, and compressed air had its triumph.

It is sad to have to record that the triumph was a brief one. An insufficiently braced bulkhead gave way so that the compressed air was not retained, and the Yankee sank again almost immediately, and all hope of raising her again was abandoned. The latest advices are that another attempt is to be made.

NEW BOOK

Through the Yukon and Alaska, by T. A. Rickard, Associate of the Royal School of Mines: Editor of Mining and Scientific Press and Mining Magazine; formerly State Geologist of Colorado. San Francisco, Mining and Scientific Press, 1909. Price, $2.50.

This is a book of 400 pages uniform in size with the Transactions of the Societies. It has 160 fine half tones from excellent photos, all pertinent to the matter and contributing to the interest of the publication as a whole. The book is full of just the right kind of information. It is also of high literary quality and is an unusually readable book for the general public.

AIR HAMMER DRILLS

At present air-hammer drills are being tried all over the country and in most camps they are being accepted as the only machine for drilling in raises, even in hard ground. In stoping the use of the air-hammer drill is confined to upholes in mediumly hard ground. Still in Butte the air-hammer drill has been used in stopes of first-class ore where much of the ore was in bands of chalcocite and enargite, with fair success— anyway at a lower cost than the two-men piston machines.

The air-hammer drill has only been adapted as yet to drilling "uppers" in which the drillings run out by gravity from the holes. The limiting angle is about twenty degrees when ribbed steel is used; as the rotation of the steel helps convey the drillings down the inclined sides of the hole. On this account ribbed steel should be used rather than hexagonal or round steel, especially as both these require shanking before use. Apparently hollow steel finds no favor in drilling uppers.

Some attempts have been made to adapt the air-hammer drill to drifting by using a hollow steel and injecting water or air into the hole through the steel. The great advancement in the near future will be in perfecting the air-hammer drill for sinking work. In medium hard rock they they have been used with some success already. Their great advantage is that the air-hammer drill does not require a large amount of space for its operation and that only one man is required to run it. So as soon as one end of the shaft is cleaned drilling can begin as is the case with hand sinking. This saves lots of time.

Much emphasis is often laid on the air consumption in the different types, but that is an unimportant item comparing one air-hammer drill with another, although in comparing the air-hammer with the large piston drill it does become important. The most important feature is the ability of the machines to stay underground and the length of time they stay away from the repair shop. While at the larger mines the air-hammer drills have not been in use on a large scale long enough to determine this as surely as for piston machines, it is evident that the repair bill is considerably less.

At present there are advocates of valve machines and valveless machines. Each claim the advantage. Which is the better type depends on which stays underground the longest and does the more efficient work at the end of a year in the stopes. When new, both types work equally well. Time and experience, not argument, can alone settle this point.

BACTERIAL ACTIVITIES IN THE AIR AND THE SOIL

Leguminous plants, and especially our own cow peas, put nitrogen from the air into the soil by means of bacteria, which live in the nodules on the roots of these plants. It is now found that other bacteria in the soil Bacterial Activities in the Air and the Soil. change ammoniacal salts into nitrites and still others convert these nitrites into nitrates. We have presumedly three families, or varieties of bacteria engaged in preparing our cultivated lands for the development of plant life. These nitrifying organisms do not add nitrogen to the soil as do the bacteria of the pea, but they make available the nitrogen that the soil already contains. It is also said that there are bacteria which break down nitrogen compounds in the soil, returning the nitrogen to the air. These are the enemies of plant life, which well cultivated soils do not support.

The Kansas Agricultural Experiment Station submits the following conclusions as resulting from extensive bacterial investigation and experiment:

1st. Deep plowing tends to increase the number of soil bacteria in both sandy and silt soils.

2nd. Deep plowing tends to increase bacterial activity and more ammonia is produced.

3rd. Deep plowing tends to increase denitrification, or the reduction of nitrites and the liberation of free nitrogen.

4th. Increasing soil temperature increases bacterial activity.

5th. An excess of moisture in the soil reduces the number of bacteria and is detrimental to bacterial activity.

6th. The maximum number of bacteria is found within the fifth and sixth inches.

7th. Bacterial life and activity seem to rise and fall with more or less regularity. These periods of maximum and minimum activity are to a certain extent independent of moisture and temperature.

GAS-ENGINE GAS COMPRESSORS

A recent example of the efficiency of the gas-engine-driven booster is the Westinghouse twin-tandem equipment in the Mohican Oil and Gas Company's plant at Howard, Ohio. The compressors deliver to the long-distance pipe lines at 165 to 200 pounds gage pressure, and the gas is received at 25 to 80 pounds pressure from wells located within a radius of 20 miles of the plant, which delivers gas to towns at distances of 80 miles. The compressor engines take their fuel from the well mains, through reducing regulators, at about atmospheric pressure. They are 1250-horsepower (23½x48-inch) twin-tandem engines and run at speeds ranging from 44 to 88 revolutions per minute; they consume, on an average, about 4 per cent. of the compressor output.

USE OF THE FREEZING PROCESS

A large flow of water encountered in a drift in the Bessie mine, on the third beach line near Nome, last summer was stopped by the freezing process. A line of holes was drilled down from the surface and across the drift. Pipes were let down these holes into the drift, and connected at the top with an ammonia machine. Sand was then shoveled into the drift through the holes, and freezing commenced. This was kept up until the latter part of August when the job was completed. A solid block of sand and ice was thus formed, connecting on all sides with unthawed ground, which completely dammed the drift and shut off the water. When this was done, the mine was unwatered and driving operations were resumed. The drilling and freezing required about a month and cost $4,000.

N. Y. HARBOR OBSTRUCTION REMOVED

Some four years ago an outgoing Atlantic liner, drawing 26 feet, struck a hitherto uncharted ledge of rock off the Battery, one of the most frequented spots in New York harbor. The work of removing the obstruction was soon begun, but rapid progress was not made until the year just closed, and on December 13 the apparatus was withdrawn, leaving a depth of 42 feet at low water. The last contractor was the R. G. Packard Company. No divers were used, the drilling and dynamiting being done from a "drill platform" on which were mounted heavy Ingersoll submarine drills, the material being taken up by a dipper dredge. About 4,000 cubic yards of rock was removed.

RULES OF THE ROAD FOR SKY NAVIGATION

The following rules have been formulated in France by the commission *Aerienne Mixte,* the ruling body in aeronautics:

Two flying machines, which, in approaching one another, seem likely to collide must both keep to the right. They must pass one another at a distance of at least 150 ft. apart, unless they are flying at altitudes differing by more than 90 ft. Dirigible airships must avoid each other by a distance of at least 1,500 ft., but are free from this condition if at altitudes differing by at least 450 ft. Every machine flying at night or during foggy weather must carry a green light on the right, a red light on the left, and a white headlight in front on top. The green and red lights must be visible in front and laterally, and the headlight must project its rays forwards and downwards.

NOTES

Mr. P. M. Haight, Treasurer of the Sprague Electric Company, was recently elected President of the Electrical Trades Society of New York.

The address of C. Drucklieb, manufacturer of the Injector Sand Blast, is changed from 132 Reade street, to 178 Washington street, New York city.

An electric pen calculated to prevent forgery or erasure or alteration has made its appearance in England. This pen makes a large number of very closely spaced, almost imperceptible perforations, and the line is rendered distinct and indelible by a slight charring of the paper around each of these tiny holes.

The headings of the new Trano-Andiere tunnel, met on November 27, and the event was made an occasion of public celebration in Chili. This tunnel is part of the railway which W. R. Grace & Company are building to join the Argentine and Chilian railway systems.

The latest bulletin of the Fidelity and Casualty Co. reports for a period of about five weeks no less than six cases of burst flywheels in the United States and Canada. The list accounts for two persons killed, several severely injured, and a large money loss.

As we are developing and putting into use devices for obtaining nitrogen directly from the atmosphere it will be in order to begin to worry about the possibility of exhausting the supply. As we figure it, the nitrogen of the atmosphere weighs only about four and a half quadrillion tons (4,500,000,000,000,000) but some of it is continually being replaced by nature's automatic processes.

Death Valley, in which the great borax bodies of southern California occur, is the lowest valley on this continent, and probably in the world, being 500 ft. below sea level. The valley is caused by a profound fault of 6,000 ft., by which a block of ground 10 miles wide has dropped from the surrounding Panamint and Grapevine ranges, falling between them as a key-block, with steep, lofty mountains on either side.

The sweetening power of saccharin, which is derived from coal tar, is almost incredible. It it said that four pounds of it will sweeten the same bulk of material as a ton of sugar. It cannot ferment and it acts in some degree as a preservative agent. Until a few years ago the industry flourished in Germany, but the opposition of the sugar manufacturers, probably, led to a law being passed in 1902 forbidding the manufacture of artificial sweetening products.

There can be no doubt of the enormous profits in mining when it is learned through a careful compilation by The Mining World that 109 American companies during the first 10 months of 1909 paid their shareholders $52,850,110. It is further learned that these 109 American mines and metallurgical works have paid since incorporation the enormous total of $589,400,250, a return on a combined issued capitalization of $549,584,825 equivalent to 107 per cent.

It is often difficult to keep machinery properly oiled in cold weather, as the oil freezes in the oil holes and the cups, and the oil upon the ways of the lathe and planer becomes stiff, causing the machines to work hard. A good oil for winter use is made by mixing graphite with cylinder oil until in a thick or pasty consistency, and then adding kerosene until it flows freely. This oil will not become stiff at 14 degrees below zero, and is valuable to those operating machinery outside or in cold shops.

The quantity of water needed at a mine bears no fixed ratio to tonnage. It depends upon the depth and the pitch of the seams, which affect both the power required for hoisting and the amount of water that has to be pumped and the distance that it has to be elevated. The wetness of the overlying strata has also a bearing on the matter. Suffice it to say that the quantity required for steam-making is large, as is indicated by the fact that, taking the coal region as a whole, ten per cent. of the coal hoisted is used for colliery purposes.

In a paper before the South Wales Institute of Engineers, Mr. C. B. Chartres proposed that a turbo-compressor should deliver the air to existing reciprocating compressors at about 15 lb. per square inch, and thus double the capacity of the compressor plant. This proposal is specially intended for collieries where low-pressure turbines can often be put down to work with the exhaust steam from the winding and auxiliary engines. It is well known that turbo-compressors are inefficient for high compressions, but this defect is not very marked at low pressures, and is offset by advantage in the form of small size and simplicity; and also, in some instances, of first cost.

A compressed air sewage lift is in use at Malvern, England, to raise the low-level flow from a population of about 1,100, a height of 28 ft .to the main outfall. Power is furnished by a 7½ hp., 200-volt alternating current motor and belt-driven compressor. Sewage first flows into a cylinder, holding 250 imp. gal., provided with a valve which is opened automatically when the chamber is full. The opening of the valve admits compressed air which forces the sewage from the tank into a rising main, 1,200 ft. long, leading to the main outfall sewer. The compressor is run for three periods of two hours each daily, and in this time lifts 55,000 gal.

The Erie Railroad has provided one car in some of its suburban trains for those who object to the steam heat and stuffy atmosphere of the regular cars. The cars carry signs reading "Fresh Air," and are started out with the doors, ventilators and alternate side windows wide open. Any person riding in these cars is privileged to close the window next to him, but has no right to insist on the closure of other ventilation openings. The will of the majority of those who ride in the cars will control the turning on of the steam, which may be wanted in very cold weather. Those who find the cars too cold can always move to other cars in the trains. This, it is considered, is a novel but sensible way of solving the vexatious problem of heating and ventilating cars in winter.

The first important discovery of natural gas in Europe is reported from Kis-Sarmas, in Transylvania, where an apparently inexhaustible supply has been found. The presence of this valuable economic asset first became known some time ago, when shepherd boys used to light the vapours rising from the marshes. Upon a geologist's report the Ministry of Finace directed proper borings to be made, when large quantities of gas were discovered at a depth of 65 ft, The borings were continued to a depth of 650 ft.. when the gas was found in such immense volume that big stones, as large as a man's fist, were thrown into the air by it. At the present time the gas is pouring out of a pipe 20 ft. above the ground with a noise that can be heard six miles away. Experts estimate the flow at 70 cubic feet a second. Analysis shows that it is a peculiarly clear methane gas, containing scarcely half of 1 per cent. of nitrogen. A Government commission of experts declare that there is little danger of the supply becoming exhausted.

LATEST U. S. PATENTS

Full specifications and drawings of any patent moy be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

NOVEMBER 2.

938,487. FLUID-PRESSURE COMBINATION-LOCK. William J. Hoffstatter, Toledo, O.

938,489. METHOD OF AND APPARATUS FOR INTERIORLY COATING TUBES. Edward James, Cleveland, Ohio.

1. The method of interiorly coating tubes, which consists in placing a quantity of the coating material in the tube to be coated in front of a relatively solid member, and then admitting a *fluid under pressure* behind said member, whereby the latter and such material are forced along such tube.

938,495. AIR-FLUE BLOWER. Louis Lunstrum, Council Bluffs, Iowa.

938,522. PUMP FOR AUTOMOBILE-TIRES. Hawden Swain, San Francisco, Cal.

938,556. BENDING-MACHINE. Robert A. Carter, Pittsburg, Pa.

938,574. AUTOMATICALLY-CLOSING VALVE. Frederick H. Goldsmith, Kansas City, Mo.

938,601. NEEDLE-VALVE. Joseph Maas, Kalamazoo, Mich.

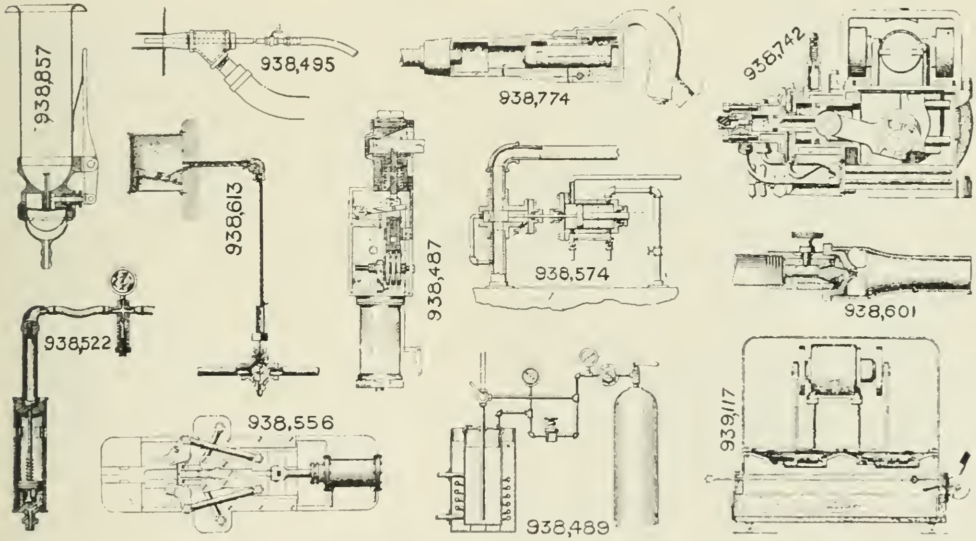
938,613. FLUID-CONTROLLING APPARATUS. Henry Sieben, Kansas City, Mo.,

938,742. COMPOUND AIR-COMPRESSOR. Niels A. Christensen, Milwaukee, Wis.

938,774. PNEUMATIC TOOL. Herman Leineweber, Chicago, Ill.

938,857. MILKING APPLIANCE. Jacob Henrichsen and Carl J. Hemmingsen, Copenhagen, Denmark.

939,117. VACUUM - CLEANER. Theodore Wiedemann and Joseph H. Templin, Philadelphia, Pa.



Pneumatic Patents November 2.

NOVEMBER 9.

939,214. BOTTLING-MACHINE. Joseph H. Champ, Cleveland, Ohio.

939,270. AIR LIFT-PUMP. Frank G. Kimball, Whittier, Cal.

939,277. AIR-VALVE. John W. Ledoux, Swarthmore, Pa.

939,307. PNEUMATIC PUMP OR APPARATUS FOR RAISING WATER BY MEANS OF COMPRESSED AIR. Thomas O. Perry, Chicago, Ill.

939,314. AIR-COMPRESSOR. Frederick A. Preuss, Green Garden precinct, Madison county, Nebr.

939,333. CENTRIFUGAL AND SIMILAR PUMP, BLOWER AND THE LIKE. Walter Scheurmann, Newark-upon-Trent, England.

939,351. HUMIDIFIER. Marshall Tillotson, Providence, R. I.

939,470. FLUID-PRESSURE REGULATOR. Francis H. Brown, Philadelphia, Pa.

939,483. AIR-SHIP. Boyd W. Dysart, Los Angeles, Cal.

939,613. LIQUID-FUEL BURNER. Benton Moore, Cherryvale, Kans.

1. A liquid fuel burner comprising an air-supply pipe open at its ends, a fuel pipe entering one end of said pipe and discharging from the other end thereof, said fuel pipe extending through the air pipe in spaced relation thereto, a T-coupling connected to the outer end of the fuel pipe, a supply pipe connected to the lateral branch of the coupling, and an elbow connected to the branch of the coupling which is in line with the branch to which the fuel pipe is connected, said elbow being upwardly presented.

939,685. APPARATUS FOR COOLING FRUITS. Marshall W. Groom, San Jose, Cal.

An apparatus for cooling fruit, which comprises a closed chamber divided by partitions into a series of runways, an endless conveyer having a receiving and a discharge portion outside said chamber, and with a sinuous portion traversing the successive runways, a cold air pipe having nozzles arranged to discharge into said runways, alternate of said nozzles discharging in a direction contrary to the travel of the conveyer, and the intermediate nozzles discharging in the same direction with the conveyer, and a source of cold air supply for said air pipe.

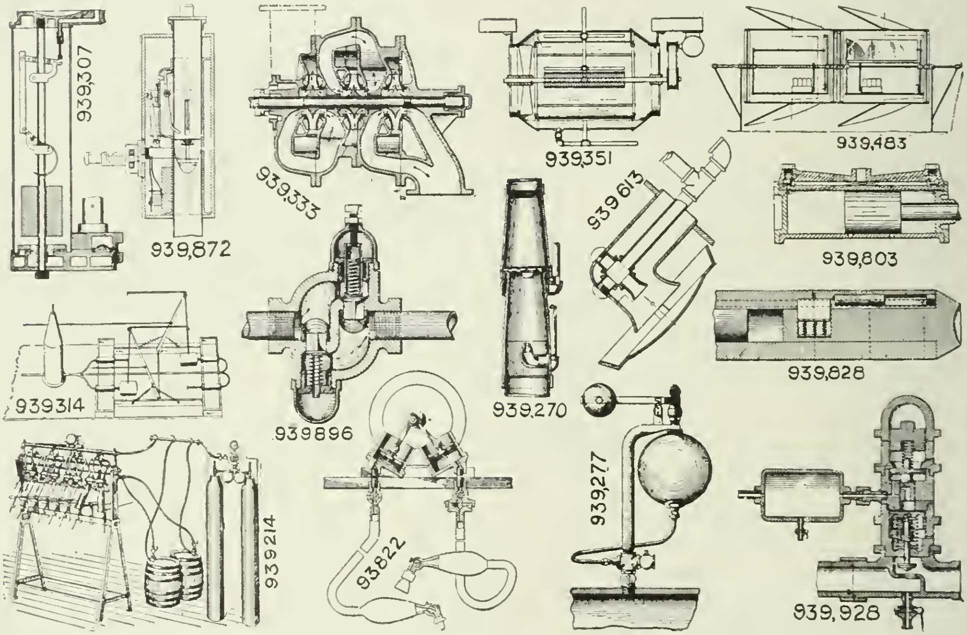
939,803. PNEUMATIC TOOL. Charles Christiansen, Gelsenkirchen, Germany.

939,822. MASSAGE AND AIR-COMPRESSING MACHINE. Joseph B. Fey, Columbus, Ohio.

939,828. PNEUMATIC HAMMER. Humphrey H. Grobes, Jersey City, N. J.
939,872. PNEUMATIC-DESPATCH SYSTEM. Percy R. Shill, Leytonstone, England.
939,896. REGULATOR FOR AIR-BRAKES. Charles J. Doerr, Erie, Pa.
939,928. AIR-BRAKE RETAINING-VALVE. Joseph F. Spiegel, Galeton, Pa.

NOVEMBER 16.

939,987. AIR COMPRESSOR VALVE. Clarence A. Dawley, New York, N. Y.
940,057. WINDMILL. Frederick A. Preuss, Green Garden township, Madison county, Nebraska.
940,123. VACUUM-SEALING MACHINE FOR CONTAINERS. Julius Brenzinger, Mount Vernon, N. Y.



Pneumatic Patents November 9.

940,141. DUST-SEPARATING TANK. Daniel Fogarty, Ottawa, Ontario, Canada.
940,142. SEPARATING-TANK FOR VACUUM CLEANING APPARATUS. Daniel Fogarty, Ottawa, Ontario, Canada.
940,144. DRIER. Charles E. Geiger, Louisville, Ky.
940,162. ELASTIC-FLUID ENGINE. Charles V. Kerr, Rutherford, N. J.

1. The combination of an elastic fluid engine, an air compressor, a combustion chamber, a burner therein, a pipe for feeding a mixture of combustible gases to said burner and having two inlet ports, valves controlling said ports, two tubes respectively communicating with said ports, a gas compressor communicating with one of said tubes, a pipe etxending from the air compressor, and communicating with the other of said tubes and separately also beyond said combustion chamber at a point to meet the products of combustion from said combustion chamber, a valve across the last named pipe and means controlled by the load on said engine for regulating all of said valves, said means consisting of a rod carrying all of said valves, and a governor connected up with said rod and with said engine.

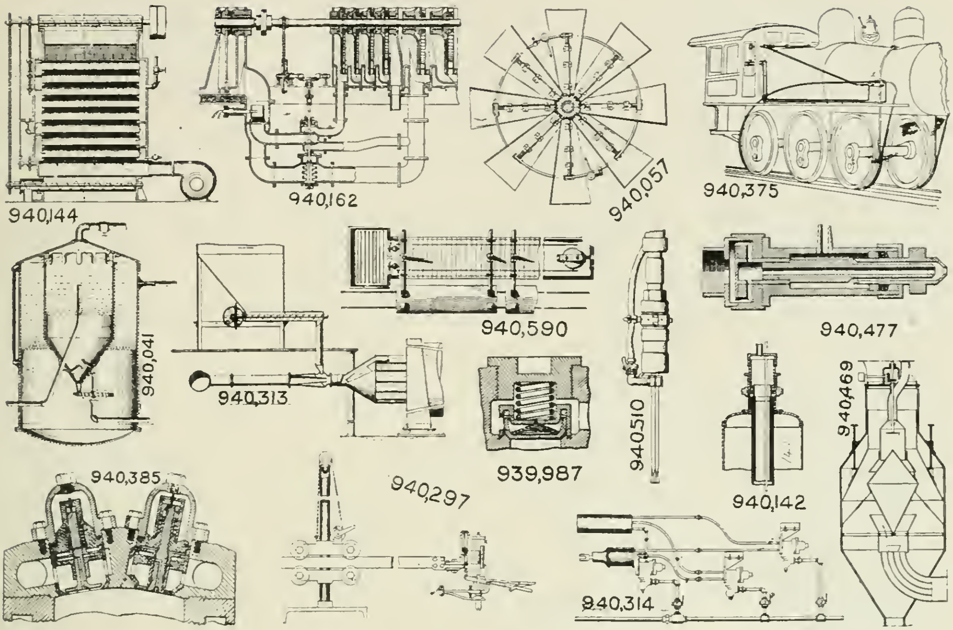
940,297. PNEUMATIC SURFACING-MACHINE. George L. Badger, Quincy, Mass.

940,313. FUEL-FEEDER. William H. Harding, Philadelphia, and Charles M. Saeger, Allentown, Pa.

2. A fuel feeder provided with means for establishing a stream consisting of a mixture of air and powdered fuel and with a plurality of straight tubes and having, intermediate of the tubes and means, an expanded mixing chamber communicating with the tubes and means, said chamber provided with means for sub-dividing the stream and the axes of the tubes being parallel with each other and with the axis of the means, whereby the mixture is discharged in lines parallel with the axis of the means for forming the stream of the air and fuel mixtures, substantially as described.

940,314. AIR-BRAKE SYSTEM. John W. Hicks, Goldsboro, N. C.
940,375. TRACK-SANDING APPARATUS. Joseph W. Stickley, Norfolk, Va.
940,385. FLUID-PRESSURE VALVE. Joseph Folco, Tacoma, Wash.
940,469. PNEUMATIC SEPARATOR. Harry N. Middleton, Westville, N. J.
940,477. SPRAYING-NOZZLE. Almon E. Preston, Battle Creek, Mich.
940,510. WATER ATTACHMENT FOR PNEUMATIC HAMMERS. Charles T. Carnahan and Jeremiah Murphy, Denver, Colo.
940,590. REFRIGERATING APPARATUS. Cassius M. Gay, Los Angeles, Cal.

1. In a refrigerating apparatus an internally refrigerated air chamber; a low pressure duct connected to the upper portion of said chamber; a high pressure duct connected to the lower portion of said chamber, said two ducts being connected at their outer ends; a pressure regulated valve on the communication between said ducts, said valve controlling the admission of air from



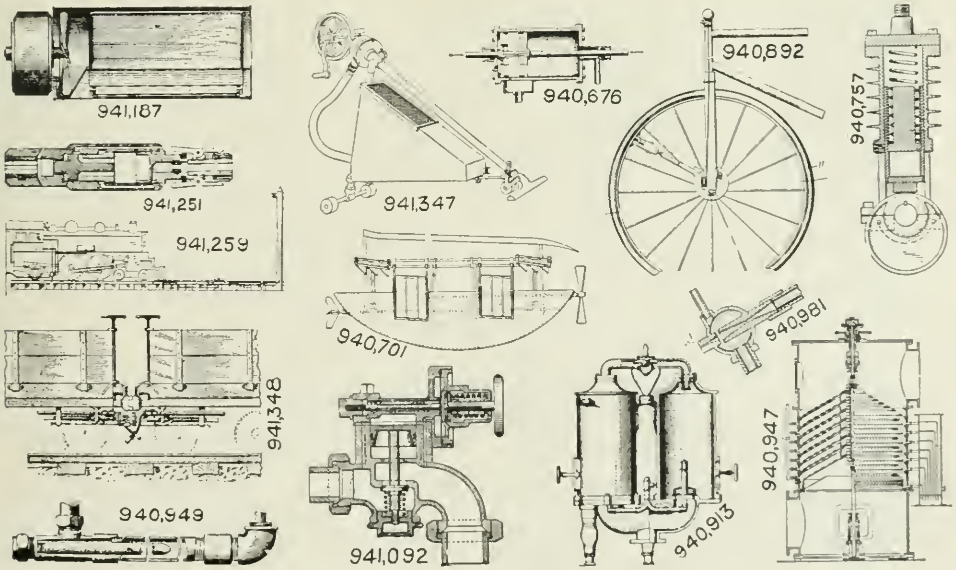
Pneumatic Patents November 16.

the high pressure duct to the low pressure duct; a pressure regulated valve opening into the low pressure duct at its outer end; and means to maintain in the low pressure duct a pressure below atmospheric pressure and in the high pressure duct a pressure above atmospheric pressure.

NOVEMBER 23.

940,676. AUTOMATIC BLEEDER FOR AIR-BRAKE SYSTEMS. Edward Van Hart Conley, 2d, Kearney, N. J.

940,701. AIR-SHIP. Henry Mesinger, New York, N. Y.



Pneumatic Patents November 23.

940,751. AIR-COMPRESSOR. William R. Thompson, South Norwalk, Conn.

940,813. LIQUID-FUEL BURNER. August Koch, Hanover-List, Germany.

1. In an apparatus of the character described a mixing chamber and a fuel nozzle adapted to inject fuel into said chamber, said chamber having two groups of apertures for leading the combustion air into it, one group of apertures located near the end of said chamber and near said nozzle, and adapted to lead one part of the combustion air into the chamber to form a whirl in one direction, the other group of apertures disposed in the wall of said chamber to lead the other part of combustion air into said chamber, in a direction substantially opposing the general direction of said whirl to produce strong eddy currents in said chamber, substantially on the line in which the fuel is injected.

940,892. AUTOMATIC AIR-PUMP. Erb Reed, Cookeville, Tenn.

NOVEMBER 30.

941,370. FRESH-AIR CONVEYER. Emory E. Lamb, Pulaski, Va.

941,443. SYSTEM OF PRECOOLING FRUIT-CARS OR THE LIKE. Arthur Faget, San Francisco, Cal.

941,450. AIR PUMPING OR FORCING MECHANISM. Horace Harsant, Penge, London, England.

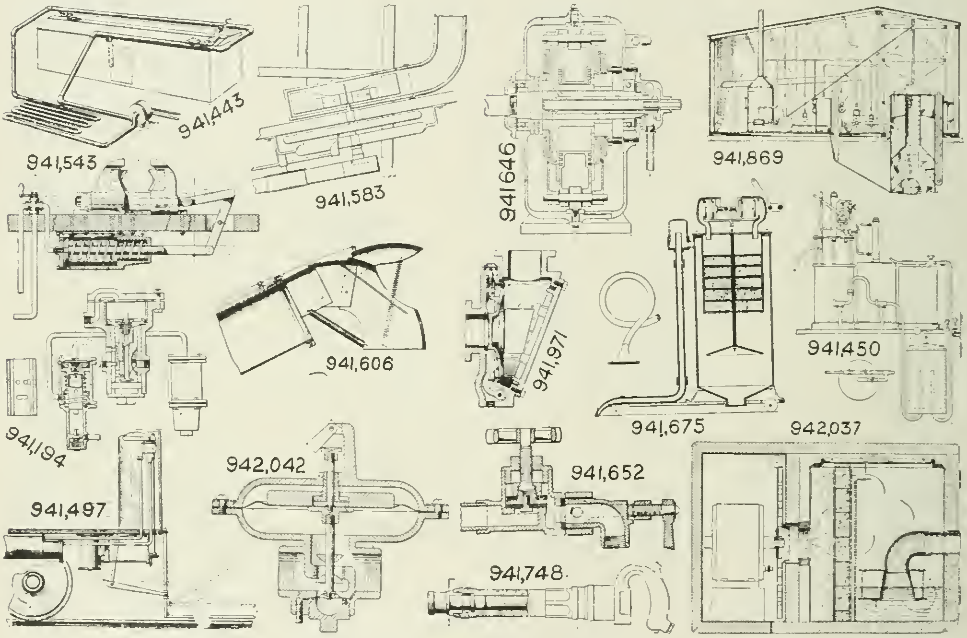
941,497. AIR-ACTUATED STREET-CAR FENDER. John M. Clancy, Chicago, Ill.

941,543. FLUID-ACTUATED VISE. John Sistek and James Spinka, Chicago, Ill.

941,583. PNEUMATIC STACKER. Peter Miller, Minto, N. D.

941,606. PNEUMATIC STRAW - STACKER. George H. Bathrick, Battle Creek, Mich.

941,627. AIR-COMPRESSOR OR PUMP. John Delbridge, Windsor, Victoria, Australia.



Pneumatic Patents November 30.

940,913. VACUUM-PUMP. Gustave H. Zschech, Berwyn, Ill.

940,947. APPARATUS FOR SEPARATING PARTICLES OF LIQUID FROM GASES AND VAPORS. Moritz Steger, Bochum, Germany.

940,949. OIL-BURNER. Walter Sutton, Sacramento, Cal.

940,981. OIL-VAPORIZER. James F. Malcom, Bluffton, Ind.

941,092. STEAM OR OTHER FLUID PRESSURE REGULATOR. William H. O'Connor, Newark, N. J.

941,187. HUMIDIFIER. Sterling H. Bunnell, New York, N. Y.

941,251. ROCK-DRILL. Herman J. Hibschle, Victor, Colo.

941,259. COMBINED SIGNAL AND AIR-BRAKE. Albert M. Jones, Hagerstown, Md.

941,347. PNEUMATIC SWEEPER. Solomon Markstein, New York, N. Y.

941,348. AUTOMATIC AIR-BRAKE COUPLING. William E. Campbell and Howard T. Ingram, Fairfield, Iowa.

941,646. AIR-COMPRESSOR. Viggo Olsen and Fritz Schroder, Bridgeport, Conn.

941,652. AIR-HOSE COUPLING. Frederick W. Rock, Detroit, Mich.

941,675. VACUUM-CLEANER. Ira L. Green, Ludlow, Vt.

941,684. FLUID-PRESSURE BRAKE. William P. A. Macfarlane, Chicago, Ill.

941,748. PNEUMATIC TOOL. Robert H. Wallace, New Brighton, Pa.
Marsh, Chicago, Ill.

941,869. CAISSON - DREDGER. Raymond A. Gardner, Los Angeles, Cal.

941,914. FLUID-PRESSURE-BRAKE APPARATUS. Murray Corrington, New York, N. Y.

941,971. DRY-PIPE VALVE. Hiram G. Baker, Montreal, Quebec, Canada.

942,037. PNEUMATIC CLEANER. Solomon Markstein, New York, N. Y.

942,042. FLUID - PRESSURE REGULATOR. Benjamin H. Petley, Seattle, Wash.

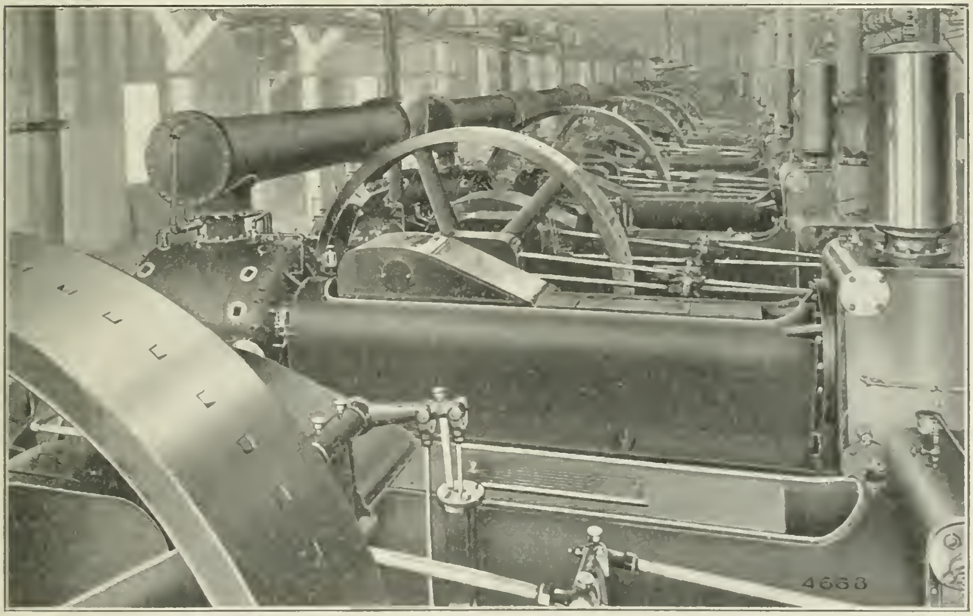
COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV FEBRUARY, 1910 No. 2

THE RONDOUT TUNNEL RECORD

The following we abstract, with slight interpolations, from a recent paper in the *Engineering Record* by Mr. John P. Hogan, Assistant Engineer, Board of Water Supply, New York City, whose position gives him unequalled facilities for full and accurate statement.

The tunnel near High Falls, N. Y., is part of Catskill Aqueduct, which will carry water from Ashokan Reservoir to New York City. It is 23,608 ft. long, 4½ miles, and is designed for a finished waterway of 14½ ft diameter and an average thickness of lining of 17 in., making the required excavation 17 ft. 4 in. in diameter. As the tunnel in service will be subjected to great internal pressure a rock cover of at least 200 ft. was considered necessary, and the line is therefore from 100 to 250 ft. below sea level and is reached from eight shafts, varying in depth from 347 to 710 ft. Three of these shafts are circular, approximately of the same size as the tunnel, and will be used permanently in the operation of the aqueduct., and five are rectangular shafts, 10x22 ft. outside of timbers, sunk to expedite construction and to be sealed and refilled at the close of the work. An unusually varied assortment of sedimentary rocks is encountered, varying from a comparatively soft shale to a hard quartz Conglomerate.

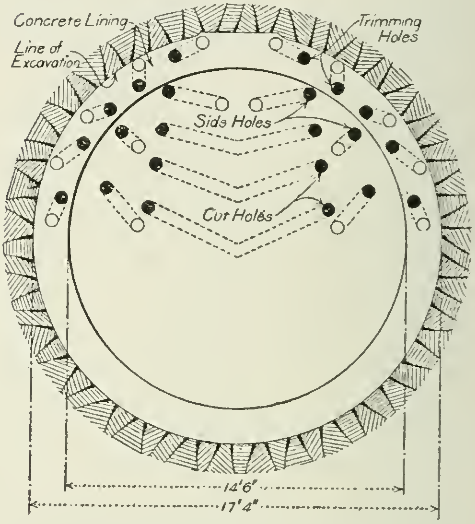


AIR COMPRESSORS AT HIGH FALLS DRIVING RONDOUT TUNNELS.

The contract for this tunnel was awarded to the T. A. Gillespie Company of New York on June 12, 1908, and the progress has been exceptionally rapid. What is said to be the largest high pressure compressed air plant in the world, comprising ten Ingersoll-Rand Imperial, compound steam and two-stage air compressors and supplying 23,000 cu. ft. of free air per minute at a pressure of 100 lb., was in operation five months after the contract was let. This plant was described in Compressed Air Magazine, June, 1909, and a photo since made of the interior of the compressor house is shown on the preceding page. The average monthly progress in seven of the shafts was about 70 ft. per shaft, and the record for a month was 138 ft., all timbered.

Heading 7S, in which a record advance of 488½ ft. was made in November, which in a way makes the opportunity for the present writing, is in the Hudson River shale, a hard slaty material with distinct stratification, the dip being about 65 deg. and the strike at an angle of about 67 deg. with the axis of the tunnel. The best-known exposures of this rock are in the cuts of the West Shore Railroad opposite Poughkeepsie and thence north for about 20 miles. The position of the strata is favorable to good progress; the rock is firm, requiring no timbering, drills well, and breaks to good lines. The tunnel is driven from a construction shaft 514 ft. deep and the heading was 1400 ft. in at the beginning of the month. The inflow of water is slight.

The method used is the typical American top heading and bench plan, approximately half of the tunnel being taken out in each operation, and enough loose muck left in the bottom to permit of two tracks just back of the bench. The bench excavation is kept about 50 ft. back of the heading to allow room for the heading muckers and is excavated in one shift. Four 3¼-in. Ingersoll-Rand drills mounted on two vertical columns are used in the heading and two drills of the same type mounted on tripods for the bench. As both excavation and concrete are paid to fixed lines, great care is taken in placing the holes, and the sections are uniformly good with small excess breakage. The number and spacing of the drill holes is shown in the accompanying sketch. The average number of holes in a heading is 22, divided into six cut holes, six side or relief holes and 10 rim or trimming holes. The cut holes are from 10 to 12 ft. deep and the remaining holes from 8 to 10 ft., depending on the amount of ground to be broken. The bench rounds are 4 ft. apart and average four holes each. Two rounds of the bench are shot with the cut, and the side and trimming holes are then loaded and shot successively, making three shots for a complete advance in which 175 to 200 lb. of 60 per cent. dynamite is used.



PLAN OF HEADING HOLES.

The contract is on a strict eight-hour basis, two shifts of drillers and three shifts of muckers being employed. The drillers work from 8.00 to 4.30, day and night, with half an hour for lunch, and the muckers from 8.00 a. m. to 4.00 p. m., 4.00 p. m. to 12.00 p. m. and 12.00 p. m. to 8.00 a. m., with 15 minutes for lunch. The drillers are expected to set up drill, load and shoot a round within the eight hours, and as no overtime is allowed, failure to accomplish this results in loss of a shot. Between 4.30 to 8.00 the muckers are expected to clean out the heading to permit setting up promptly. The drilling force consists of a heading foreman, six drillers, six helpers and a nipper.

While the rock is easily drilled the tunnel is of such a size and shape that the mucking limits the possible progress. The required excavation is 8.7 cu. yd. of solid rock per linear foot, but the cross-section does not permit the use of a steam shovel or other mechanical device for loading the muck, so hand methods are used entirely. One 30-in. gage track runs from the bottom of the shaft to the bench, where two tracks are maintained for a short distance. Switches are installed at intervals of about 1000 ft. to permit passage of cars. The heading muck is loaded in wheel barrows and wheeled out on an elevated running board supported on horizontal struts whence it is dumped directly into the cars. The cars are handled in groups of two, one of which is loaded from the heading and the other directly from the bench to encourage competition. Steel side-dump Koppel cars are used having a maximum capacity of 40 cu. ft. of loose rock and these cars are hauled by mules both below and above ground. The mucking force for the heading consists of one foreman, eight shovelers in heading, four wheel barrow men, six shovelers on bench, two mules and drivers and a water boy.

The shaft is equipped with a pair of balanced cages each 68x94 in. operated by an 11x14-in. Lambert hoisting engine. The normal hoisting speed is about 400 ft. per minute and the safety devices include landing dogs, automatic gates, safety dogs on the cages and an automatic cut-off on the engine for the prevention of over-winding. Ventilation is supplied through a 14-in. pipe by an electrically operated No. 6 Sturtevant blower. The force employed at the shaft consists of one day and one night superintendent and one master mechanic for both headings, one signal man at top and one at bottom and a hoist runner, blacksmith and helper for each of the three shifts. In addition there is a top man, a mule and driver, and a dumpman for each heading and a varying number of electricians, pipe fitters, machinists, etc.

All of these men, with the exception of the muckers, receive, as a bonus, 1 per cent. of their salary for every 5 ft. made during the month in excess of 225 ft. At the time of the inauguration of the bonus system the muckers received a flat raise from $1.60 to $1.75 per day.

In comparing this progress with other American and European records attention is called to the fact that the tunnel is driven from a deep shaft, to the limitations imposed by the size and shape of the tunnel and the eight-hour law, and to the fact that economy has not been sacrificed to speed. During the month one day was lost on account of necessary repairs and alterations at the shaft. The tunnel is just of the awkward size where the amount of muck represents a serious problem and no satisfactory mechanical device can be used. The circular shaft does not lend itself to the use of the horizontal bar of the European drill carriages on account of the difficulty of drilling the trimming or rim holes.

It is significant that the recent marked advance in American tunnel progress has spread from the Rocky Mountain territory to the eastern part of the country, both to Chicago and New York. It is felt that this is in a large measure due to an improvement in organization and system and to the gradual training in the different localities of skilled corps of tunnel workers who make a specialty of this class of work.

The Rondout Pressure Tunnel is being constructed by contract for the City of New York under the direction of the Board of Water Supply; Messrs. John A. Bensel, president, Charles M. Chadwick and Charles A. Shaw. Mr. J. Waldo Smith is chief engineer; Mr. Robert Ridgway, department engineer, Northern Aqueduct Department; Mr. Lazarus White, division engineer, Esopus Division, in which the Rondout tunnel is located, and Mr. Bertrand H. Wait, section engineer, Section No. 6. The T. A. Gillespie Company are the contractors. Mr. Robert Swan, vice-president and general manager, Mr. R. J. Gillespie, general superintendent, and Mr. John Dillon, superintendent of heading 7 S, in which the record was made.

AN INDEPENDENT DIVING OUTFIT

A new diving apparatus invented by a German engineer, was tried recently in the River Trave, at Lubeck. The apparatus renders the diver totally independent of any attendant vessel. In a small steel cylinder he carries a quantity of oxygen and a long air-pipe is not required. It is stated that the diver, with the new apparatus, can work under water for several hours, and be perfectly free in his movements, before coming again to the surface. The trial is reported to have been a perfect success; the diver descended into the River Trave, remained under water a long time, and came up again quite fresh and vigorous. By the aid of ingeniously constructed valves, oxygen is paid out from the cylinder at a rate to suit the requirement of the diver's lungs.

ANIMALS USED IN GAS TESTS

At a recent meeting of the South Staffordshire and Warwickshire Institute of Mining Engineers an important lecture was delivered jointly by Drs. I. S. Haldane and C. Gordon Douglas. In the course of the lecture many experiments were made with birds, mice and other animals and in the beginning an explanation justifying their use was presented.

Mining engineers have no need of a test for a gas which shows its presence, as many gases do, by causing pain or discomfort; and in common with other educated men they dislike all cruelty to animals. It is just because carbon monoxide has the special peculiarity of causing no pain or sensible discomfort in its action that a special test for it is required. For the same reason the use of small animals in detecting carbon monoxide does not come under the Vivisection Act.

The principle of the test is as follows:—In small warm-blooded animals, the rate at which chemical changes occur in a given body-weight is enormously greater than in large animals. Thus a mouse weighing about half an ounce consumes about fifteen times as much oxygen as half an ounce of the human body would consume in the same time. A reason for this difference is evident enough. With bodies of the same shape and composition, but different sizes, the surface increases as the square of any corresponding dimension, but the mass as the cube. The larger an animal is, therefore, the less surface will it have for a given mass, and the less rapidly will a given mass of it lose heat to the environment; or the less heat, and consequently the less oxygen, will a given mass of it require in order to maintain the normal body temperature. Not only are the chemical changes in the small animal far more rapid, but the rates of respiration, circulation, etc., are correspondingly increased. It is difficult to count by the eye the rate of breathing in a mouse, and quite impossible to count its pulse rate. By a photographic method of recording the electrical changes which accompany the heart beat, Miss F. Buchanan, of Oxford, has recently shown that the pulse rate in mice and small birds is from 700 to 1,000 per minute.

It follows that the small animal will absorb any poisonous gas far more quickly than a man will, and will therefore show symptoms of poisoning far sooner. It can, in fact, be employed to show what will ultimately happen to a man if he remains in the poisonous air. This, and this alone, is the principle of the test. The small animal is not, in the long run, more sensitive than a man to a given percentage of carbon monoxide. Indeed, the opposite is almost certainly the case; for the central nervous system is in many ways more liable to harm than that of any lower animal, and an animal seems to recover much more readily and rapidly from the effects of the gas than a man does. The writers have never observed in animals any of the after-effects which so commonly follow partial poisoning by carbon monoxide in man.

As is now well known, carbon monoxide exercises its poisonous action by combining, to the exclusion of oxygen, with hæmoglobin, the red colouring matter of the blood, and thus preventing the hæmoglobin from exercising its normal function of conveying oxygen from the lungs to the tissues of the body. With the comparatively small percentages of carbon monoxide met with in mines, it takes a considerable time for enough of the gas to be absorbed into the blood of a man to produce appreciable symptoms. Even with a poisonous proportion of carbon monoxide in the air it may take half an hour to produce serious symptoms, while a mouse or small bird is correspondingly affected in two minutes. With smaller, but still serious, proportions of the gas it may take as much as two or three hours for symptoms to be produced in a man. Thus with 0.1 per cent. of carbon monoxide in the air the writers have found that it took about two hours before giddiness, etc., began to appear in one of them during rest. Periodic analyses of the blood showed that absorption was proceeding steadily, and that another half hour would have sufficed to produce practical disablement. A mouse is similarly affected within ten minutes.

With less than about 0.02 per cent. of carbon monoxide in the air, noticeable symptoms are never produced, since absorption ceases when the blood becomes saturated to a comparatively slight extent, although even this would take several hours during rest. Owing to the fact that a state of equilibrium tends to establish itself between the carbon monoxide in the blood and that in the air breathed, and that this equilibrium may be established at various levels, corresponding (if any symptoms at all are produced) to various degrees of disablement, there is a very wide range between percentages of carbon monoxide which will cause sensible inconvenience and those which will cause death. Men may be disabled for hours or days by carbon monoxide in mines, and yet finally recover. The writers do not know accurately what percentage of the gas is required to cause death in a man within an hour or two, but usually about 0.5 per cent. is needed in an animal, although as little as 0.2 per cent. may be fatal. Analyses made by the writers, of the blood of men who have been killed at various colliery explosions show that the hæmoglobin is usually about 80 per cent. saturated with carbon monoxide when death occurs. On the other hand, it is known from experiments on man published by one of the writers in the *Journal of Physiology,* that practical disablement occurs when the blood is about 50 per cent. saturated with carbon monoxide.

The lecturers then proceeded to show the effects of carbon-monoxide on small animals. A canary in a cage, and several mice, were placed in a large bell-jar of about 15 gallons capacity. By means of soft wax the bell-jar was fixed airtight on a painted wooden slab, through which passed a tube through which a man could breathe the air of the bell-jar, and the axle of a small fan for mixing the air. For the purpose of comparison, other animals were placed in a second bell-jar containing pure air. From a measuring cylinder containing pure carbon-monoxide sufficient of the gas was then driven by a stream of water into the first bell-jar to raise the proportion of carbon-monoxide to about 0.1 per cent., the whole of the air being at the same time thoroughly mixed by means of the fan. It was seen that in the course of about eight or ten minutes all the animals became sluggish in their movements, and less lively. The canary seemed rather uncertain on its perch, and the mice remained quiet, or frequently stopped, as if they became faint after a slight exertion. On doubling the percentage, these symptoms became exaggerated, and the legs of the animals tended to sprawl. On removing the bell-jar, all the animals became normal again after two or three minutes.

The bell-jar was now replaced, and about 0.6 per cent. of carbon-monoxide was driven in, the air being mixed by means of the fan, as before. At the same time, one of the writers began to breathe the air of the bell-jar through the breathing tube. In about two minutes all the animals became helpless, and rapidly became comatose or died, while the person breathing the mixture was quite unaffected, even after ten minutes. A drop of his blood was then taken from a finger and diluted in a test-tube with water to the same depth of colour as a diluted sample of normal blood previously prepared. It was seen that the sample taken after breathing the carbon monoxide had a distinct pink tinge, but was not nearly so pink as a sample of the normal blood after it was saturated with carbon-monoxide by shaking it up with coal gas. The degree of pinkness indicated that the sample from the finger was about one-fourth saturated with carbon-monoxide, this degree of pinkness being insufficient to cause appreciable symptoms.

If a mouse is used for testing, the animal should be in a cage large enough for it to creep about; otherwise, there will be difficulty in judging the effect of carbon monoxide upon it. For the same reason, a bird should have a perch in its cage. Birds are more easily killed by carbon monoxide than mice, owing, probably, to the fact that they are apt to struggle if they lose their balance, and that any sudden exertion is dangerous. In one sense, therefore, the bird is a better indicator of carbon monoxide than a mouse. But if the animal dies, it ceases to be of use as an indicator, just as a safety lamp becomes useless if it is extinguished. From this point of view, the mouse is superior. A miner needs to know, not only whether he is in dangerous air, but whether he has got back to safe air. If animals larger than mice or small birds are used, it must be remembered that they take a correspondingly longer time to react to the carbon monoxide. A rat or pigeon will take about twice as long as a mouse, a rabbit twice as long as a rat, and so on up to a horse, which probably takes twice as long as a man. The rate of recovery from carbon-monoxide poisoning is correspondingly slower in the larger animals.

A man who is moving about breathes much more air than a man at rest, but the rate at which he absorbs carbon monoxide does not increase in the same proportion. The carbon monoxide may, however, be absorbed about twice as fast as during rest. Even, however, if this is the case, it will take seven or eight times as long for the man as for the mouse to be affected.

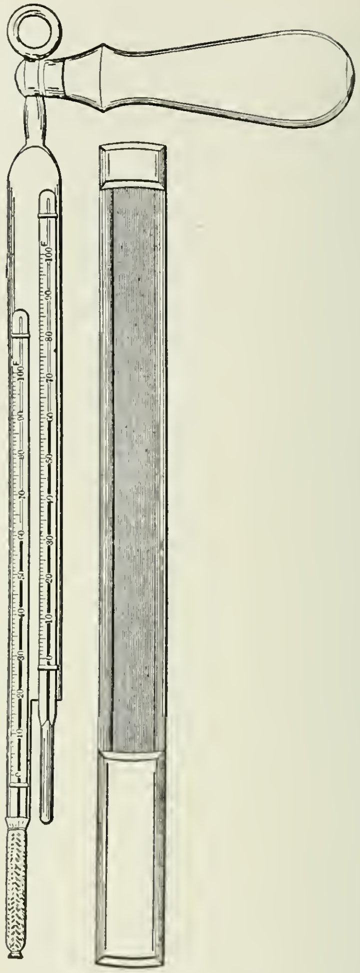
DEALING WITH ATMOSPHERIC HUMIDITY

Our atmosphere consists principally of a mechanical mixture of nitrogen, oxygen and aqueous vapors. The per cent. of the last-named component varies almost constantly under natural conditions, and as a matter of fact is kept from varying under artificial conditions only with great difficulty. Where abnormal humidity exists, as in cold-storage warehouses, where the cooling of partially saturated incoming air often produces a condition of saturation, and where the per cent. of saturation may also be increased by the moisture cooled from the products stored, a deliquescent moisture-absorbing salt, such as calcium chloride, may be employed to reduce the humidity. The salt is usually exposed to the air on shallow trays provided with drip pipes which may be arranged to convey the saturated calcium-chloride brine away to a storage tank to await reclaiming, or the brine may be employed as a deporting agent on the ammonia or brine pipes over which it may be arranged to drip slowly as formed.

The only exact method of regulating the humidity of air is artificially to cool it to such a point that the amount of moisture that it will still retain at that temperature, usually after precipitating a large per cent. of its initial complement, will be the required amount when the temperature is allowed to rise to the required point. This general process is employed most extensively in connection with the dehumidifying of air used in blast-furnace work.

The humidity of the atmosphere may be determined by one of two methods: First, by cooling the air until the point of saturation is reached, in which case the per cent. of humidity for any other temperature can be readily determined from well known tables or, second, by observing the drop in temperature produced by the evaporation of a film of water at the original temperature.

Apparatus for determining humidities by the former method are known as "dew point" instruments and by the latter method as "psychrometric" apparatus, more commonly called hygrometers. These instruments are of many forms, but the two most common types are the stationary wet- and dry-bulb thermometer of which the most practical seems to be Lloyd's Hygrodeik and a sling wet- and dry-bulb thermom-apparatus known as the "sling psychrometer." This instrument is employed by the United States Weather Bureau and is the most popular humidity-determining instrument employed in cold-storage work, especially when iow temperatures are to be dealt with.



THE SLING PSYCHROMETER.

The instrument consists of two thermometers so mounted on a common scale that one bulb extends below the other. This bulb is covered with a thin layer of muslin which is kept saturated when the instrument is inserted in its case, which is provided with a cup kept full of water. This cup is only sufficiently deep to allow the lower muslin-covered bulb to enter, the upper bare bulb being always dry.

In taking observations the instrument is removed from its case and swung rapidly around on its pivoted handle. Contact with the air produces a rapid evaporation of the moisture on the wet bulb, which evaporation causes that thermometer to register a lower temperature than that of the dry-bulb thermometer. The difference in the readings of the two thermometers constitutes a basis for arriving at the per cent. of humidity present in the air tested.—*Power and the Engineer.*

COMPRESSED AIR REGULATIONS IN FRANCE

A decree of the French republic imposes upon all persons in charge of work in compressed air a number of definite obligations looking to the safety of the men employed. The following, abstracted from *Annales des Ponts et Chaussees,* gives the principal requirements:

A physician shall be employed and shall have medical supervision of the men, and before a man may enter the air he must show this physician's certificate. The certificate must be renewed 15 days after first employment, and thereafter once a month. Provision is made for examining men who have special troubles with nose, throat or ears. An individual record mentioning accidents or cases of illness must be kept of each member of the force. Intoxicating liquors must be excluded, and any workman intoxicated must be kept away from the work for 24 hours.

The time for compression shall be at least 4 min., when increasing from 1 to 2 atmosphers, total effective pressure, and at least 5 min. for each additional atmosphere.

The time for decompression shall be not less than 20 min. for each atmosphere above 3, absolute, 15 min. for pressures between 2 and 3, and 10 min. from 2 down to zero gage pressure.

If the pressure has not exceeded 2 atmospheres, 15 lb. gage, the time to decompress down to zero may be reduced to 5 min.

A caisson may not be lowered by suddenly reducing the pressure without first taking out the men.

Every lock must have a pressure gage, and if the gage pressure exceeds one atmosphere a recording gage is required.

The working chamber must be high enough for men to stand upright in it, and never less than 5 ft. 11 in.

At least 40 cu. m. (1,412 cu. ft.) must be supplied per hour per man, and carbonic acid must not exceed 1 in 1,000. If the air supply stops the men must be ordered out after 10 min. at the most.

Blasting is not permitted in the working chamber until the men have left it, and they must not reenter until the air has become normal, temporary refuge in shaft or lock being permitted.

The volume of air in the lock shall be at least 600 cu. decimeters (about 21 cu. ft.) per man. The renewal of air in locks during periods of decompression exceeding 10 min. shall be assured by opening simultaneously inlet and outlet valves thus allowing a flow of air through the lock. In summer locks exposed to the sun shall be protected by a tent or matting kept wet. When the work requires more than 20 men in the air at one time, communication between the working chamber and the surface shall be provided for by a telephone.

Special precautions should be taken to prevent, in case of an attack of giddiness, a man's falling at the entrance to the lock. Provision also is made for controlling entrance to and exit from the air from both the high and low pressure sides. The shaft should be accessible at all times and ladders maintained in it. Equipment must be provided for taking out workmen if they are unable to climb the ladders. The air lock, shafts, and working chamber shall be illuminated by electric lights.

Each air pipe shall be fitted with a check valve, which will close when the pressure in the working chamber exceeds that in the pipe. Automatic regulation of the pressure of air sent into the caisson should be provided for. An outfit for affording aid to the injured shall be kept on hand; it shall include a tank of oxygen under pressure, or other means of supplying quickly and easily a quantity of pure oxygen.

When work is carried on under an effective pressure of more than 17 pounds gage, a house, where the men coming from the air may rest, shall be built near the entrance to the work; its dimensions shall depend upon the number of men working simultaneously in the compressed air. It shall be suitably ventilated, heated, and fitted with wash stands, soap and towels for each workman, dressing room, and couches. When the pressure in the working chamber exceeds 30 pounds, gage, there must be installed a hospital-lock, containing a bed, and large enough to receive two attendants.

Compressed air workers must be at least 18 years old.

TWO-STAGE AIR FROM A SINGLE-STAGE COMPRESSOR

Mr. George L. Fales gives in *Power and the Engineer,* from which the accompanying cuts are taken, an interesting account of the taking advantage of circumstances in connection with a standard air compressor by which its output was considerably increased, its working temperatures were considerably lowered and the cost of compression per unit of volume also reduced, while the cost involved in the arrangement was not large. The narrative treats in fact of the converting of a single-stage compressor into a two-stage machine by using a portion of the air from a compressor in low pressure service as first-stage air in the regular compressor.

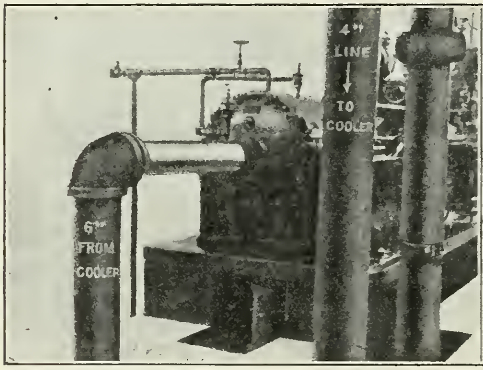


FIG. 1. AIR CYLINDER OF AIR COMPRESSOR.

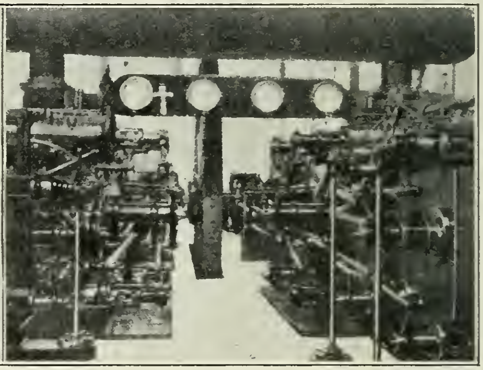


FIG. 2. CONVERTER BLOWING ENGINE.

The main object of this conversion was not so much one of economical compression as an increased output of compressed air. The compressor is an Ingersoll-Sergeant straight-line, piston-inlet type, 18 and 18¼ by 24 inches, compressing air to a pressure of 120 pounds per square inch. The pressure is too high for one-stage compression, but is necessary on account of using the air to move sulphuric acid.

With normal consumption of air this compressor and a smaller two-stage machine were just about enabled to supply the required amount of air at very near their maximum speed, the supply going not only to pump acid but also to tamp converters, for boiler-shop work, etc. This was 24-hour duty, and when repairs were needed on either compressor the supply of air was always short until the compressor was again in service. At the pressure and speed, 100 revolutions per minute, at which it was necessary to operate to get the required pressure with the Ingersoll compressor, the air was so hot when delivered that occasionally the oil in the receiver would ignite and burn, and the packing on the air-cylinder heads would char and blow out.

This compressor happens to be located between two Nordberg Corliss cross-compound blowing engines, 15 and 30 and 40 by 42 inches, compressing air to 12 pounds for blowing converters; each of these engines has a large air receiver connected to the outlet flanges over each air cylinder, and the two receivers are connected by two 12-inch lines of pipe running horizontally between the ends.

The 12-inch line pipe, shown in Fig. 3, was used as a source of supply of first-stage air. The pipe was cut on the bottom side and a 4-inch saddle flange riveted on; a short nipple and valve *A* were put on and a tee with valve *B* attached, thus connecting the 4-inch line to the atmosphere. From the tee the pipe continued down through the engine-room floor to the intercooler, through the intercooler and up through the floor again to the Ingersoll compressor, going through an inclosing sleeve around the piston-inlet pipe. The cooling-water line for the air compressor jacket was fitted with valves *F*, *G* and *H*, and the water was bypassed as shown, going into the jacket after it had first passed through the intercooler. The drip line and valve *I* removed the oil and water that accumulated in the bottom of the intercooler. To run single-stage, the valve *A* is closed and valve *B* is opened, using air at atmospheric pressure through the intercooler.

The intercooler, shown in section in Fig. 4, was a piece of 12-inch pipe, 10 feet long, with flanges attached at each end. The tube sheets were two blank flanges 1 inch thick, drilled and recessed as shown in the drawing. On the inside of one of the tube sheets a baffle plate was riveted in the center, extending the whole width of the pipe and three-quarters of the length, to make the entering air traverse the full length of the tubes. The heads on each end were ¾-inch iron, flanged and dished, and twenty-eight 1⅛-inch brass tubes were inserted through stuffing boxes. A 4-inch saddle flange on each side of the 12-inch pipe at one end provides entrance and exit for the air, and a 1-inch opening on the bottom at the opposite end acts to drain the intercooler. The 4-inch line going from the intercooler to the compressor ends at the floor line in a reducing 6-inch flange which is tapped out for ¾-inch cap screws instead of bolts; from this flange a 6-inch companion flange and a piece of 6-inch pipe extend upward to the 6-inch ell fitted at the end next to the compressor. A stuffing box and gland inclosing sleeve *A* fit into the other end of the ell and allow for any expansion or contraction. When it is necessary to pack the compressor gland, the cap screws on the 6-inch flange at the floor are removed, and the sleeve and packing gland, which are all one, are moved out enough to enable packing to be inserted in the stuffing box.

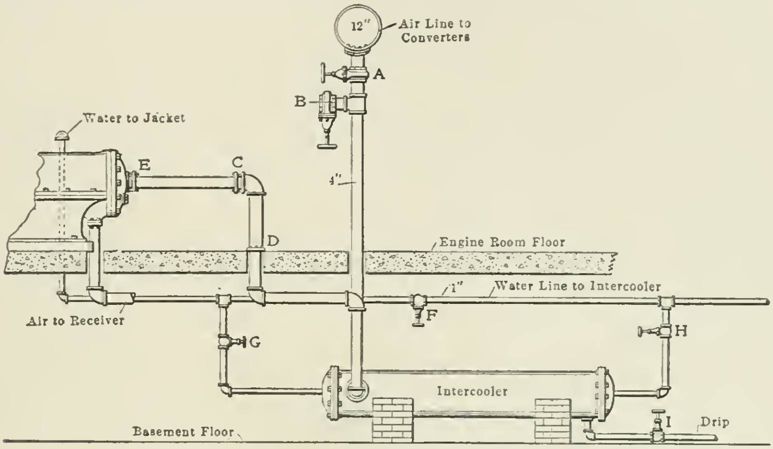
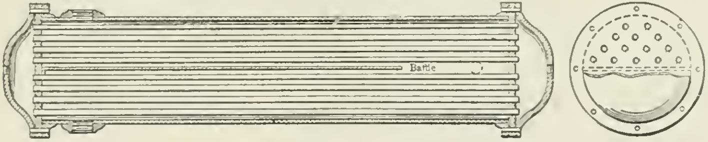
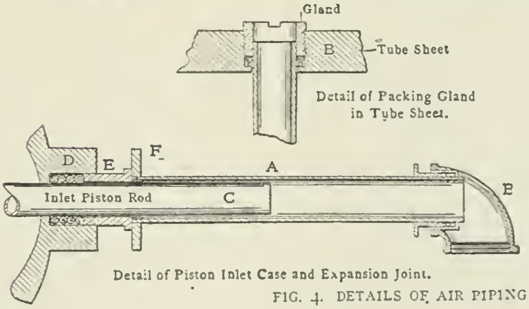


FIG. 3. PIPING TO AIR CYLINDER OF COMPRESSOR

Section of Intercooler showing Tube Arrangement.





Detail of Packing Gland in Tube Sheet.

Detail of Piston Inlet Case and Expansion Joint.

FIG. 4. DETAILS OF AIR PIPING

A detail of the sleeve inclosing the piston inlet pipe is shown in the drawing to consist of a piece of 5-inch pipe, turned smooth on the outside. The original packing gland *E* was cut down as illustrated, leaving a shoulder which sleeve *A* was forced up against and pinned in place. A flange *F*, which fits loosely on the sleeve *A*, was made to fit up against the shoulder on the gland and holds it in place against the packing. being drawn into the stuffing box by the original gland bolts.

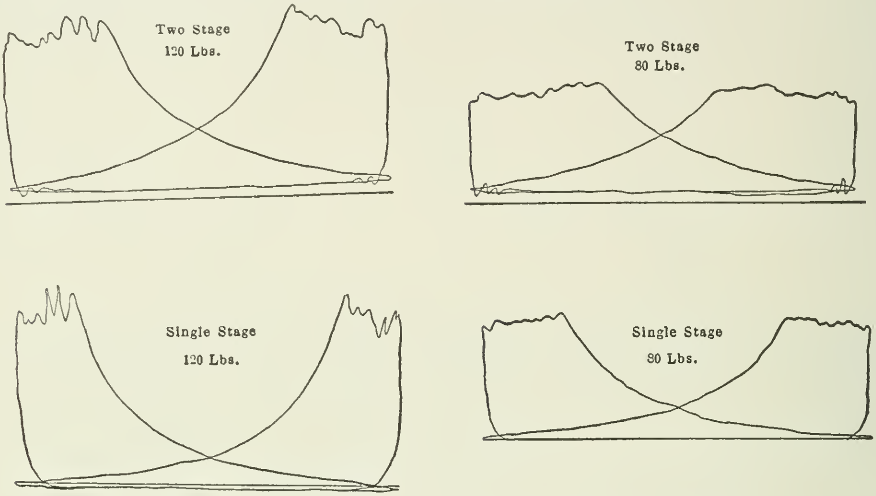


FIG. 5. DIAGRAMS TAKEN ON SINGLE-STAGE AND TWO-STAGE OPERATION

The tracings of the indicator diagrams taken from the air cylinder show the comparative increase of volume in delivered air due to the compounding and intercooling. Since running two-stage the smaller two-stage machine has not been in service at all, except when repairs were being made on the Ingersoll compressor, and then it was put on to hold what air it could until the compressor under repairs was again in service. As a consequence there is always a spare compressor, a plentiful supply of air obtained at a medium speed of the compressor, and the delivered air is at a much lower temperature. There has been but one joint put in the air head since the compressor has been running two-stage, which is five or six months; previously it was about twice a week.

LUBRICATION.

Once on each shift of 12 hours a cake of white soap is dissolved in two gallons of water and fed into the air cylinder through an oil cup on the inclosing sleeve of the piston inlet. This keeps the valves, packing rings, etc., so free from the carbon deposits that the compressor never has to be opened to clean up from this cause. The amount of air used from the converter engine is hardly discernible, as the same amount of work is done with the engine as formerly; it takes some seven or eight revolutions of the converter engine per 100 revolutions of the compressor. Figs. 1 and 2 show the Ingersoll-Sergeant compressor as fitted up and also the engine which supplies the first-stage air.

COMPRESSOR DISCHARGE PIPE PULSATIONS

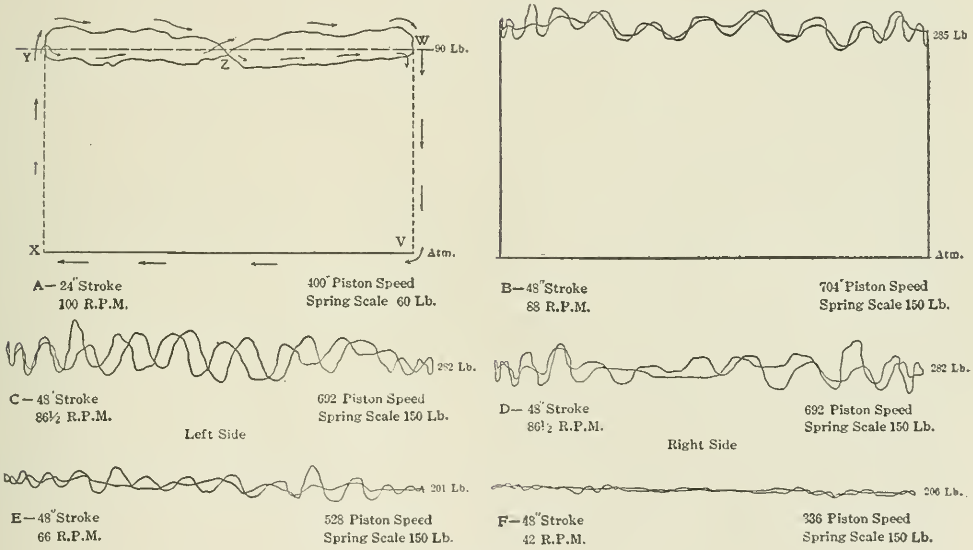
By Snowden B. Redfield.

A great many questions have been asked as to what causes the wide variation in the pressure delivered by an air compressor as shown by the very wavy line of discharge on the indicator card. The only explanation for these irregular lines lies in possible pulsation in the air as it is forced out of the compressing cylinder.

These pulsations are not always alike, or, it should be said are seldom alike, although under given conditions an indicator card from the same compressing cylinder will really show exactly the same wavy lines. Sometimes these pulsations appear to be very much more violent than at other times, and it is found that the higher the speed and the smaller the valve area provided in the compressor, the more amplitude there is to the waves shown on the discharge line of the indicator card. At very slow speeds the vibrations can be almost eliminated with indicator springs of the usual stiffness.

Another way of studying these interesting pulsations in the air pipe leading from an air compressor is to take an indicator diagram from the discharge pipe itself by attaching an indicator to the side of the pipe close to the air cylinder, or wherever it is desired to study the pulsations in the pipe.

It is a curious thing that the figures obtained in this way are always the same as long as the conditions of speed and pressure are unchanged for any particular compressor and position in the discharge pipe, and no matter how violent these vibrations may be, due to high speed, the indicator pencil will go right on over the same lines of the complicated figure produced as long as may be desired. One would think that the pulsations would change from instant to instant when the figure becomes very irregular, and that the diagram produced by continuing to allow the pencil to trace upon the indicator card would finally become nothing but a snarl of lines.



A—24" Stroke 100 R.P.M. 400' Piston Speed Spring Scale 60 Lb.

B—48" Stroke 88 R.P.M. 704' Piston Speed Spring Scale 150 Lb.

C—48" Stroke 86½ R.P.M. 692 Piston Speed Spring Scale 150 Lb. Left Side

D—48" Stroke 86½ R.P.M. 692 Piston Speed Spring Scale 150 Lb. Right Side

E—48" Stroke 66 R.P.M. 528 Piston Speed Spring Scale 150 Lb.

F—48" Stroke 42 R.P.M. 336 Piston Speed Spring Scale 150 Lb.

FIG. 1.

THE DIAGRAMS.

In Fig. 1 there are reproduced several diagrams obtained from compressor discharge pipes. There is shown at *A* an ordinary pipe diagram with moderate speed and moderate pressure. This diagram, as might be predicted, takes the form of an elongated Fig. 8, the high parts corresponding to the period of discharge of first one end of the cylinder and then the other, while the low parts are produced during the interval when no air is being forced into the pipe from the compressor; that is, during that part of the compression stroke before the pressure in the cylinder has reached that of the discharge. All of the other diagrams were taken from a compressor pumping natural gas. The various pressures and speeds are marked and it will be seen that for each pressure and each speed there is a distinct diagram for any one cylinder, although, as said, each diagram can be reproduced from a given pipe any number of times as long as the speed of the compressor and the discharge pressure are kept constant.

As the speed decreases the diagram becomes of less and less amplitude, so that at *F*, the lowest speed, it is almost a straight line. At *F* the piston speed is only a little less than at *A*, but it is seen that the diagrams are widely different. This difference is due to two things; first, the scale of the spring in the two cases is entirely different, being 60 pounds per inch at *A* and 150 pounds at *F*. This stiff spring, of course, causes the pulsations to appear of small amplitude, although the actual pressure variations may be as great in the case of *F* as of *A*, but *F* is comparable only with *B, C, D* and *E,* taken with a 150-pound spring, and these correctly show the relative effect of speed change under otherwise similar conditions..

THE PRACTICAL USE.

These diagrams may be very curious to look at, but the question naturally arises what are they good for? As a matter of fact, these diagrams may be made to serve a very useful purpose; that is, to determine absolutely what is known as the efficiency of compression of the compressor. The efficiency of compression is the ratio of the theoretical power required to compress a given quantity of air or gas from any one pressure to another, to the actual power required to be developed in the compressing cylinder.

The efficiency of compression depends, for given conditions of pressure and speed, upon the valve area of the compressing cylinder, and consequently is a factor which may be improved by first-class construction. In buying an air compressor, therefore, it is very advisable to find out beforehand what guarantee as to efficiency of compression will be made by the manufacturer. The purchaser almost always asks what volumetric efficiency will be obtained, but the efficiency of compression is usually allowed to remain quietly in the background.

Of course the theoretical power for any given pressure conditions may be figured either by the adiabatic or the isothermal formula, or in fact for any other compression curve. The isothermal is the best that can be hoped for, although never attained with an air compressor, but the adiabatic is very much more nearly equal to what is actually obtained from ordinary compressor practice. It makes no difference which figure is used for comparison as long as it is clearly understood which efficiency (that is, the isothermal or adiabatic) is intended.

THE EFFICIENCY OF COMPRESSION.

As an example of efficiency of compression referred to the adiabatic, we may take the indicator card shown in Fig. 2. This card also was taken from a natural gas compressor and, as is usually the case with natural gas, the intake pressure was very considerably above the atmosphere. The intake pressure to the compressor was 51½ pounds gage, and the gas was then compressed up to 281 pounds, the actual discharge pressure measured in the pipe. Now the theoretical power required to adiabatically compress 100 cubic feet of natural gas from 51½ pounds to 281 pounds at sea level is 49.9 indicated horsepower per 100 cubic feet of gas actually compressed and delivered per minute.

By going over the indicator card shown in Fig. 2 it is found that the mean effective pressure developed in this cylinder is 112½ pounds per square inch. This mean effective pressure corresponds to 49.2 indicated horsepower per 100 cubic feet of piston displacement of the compressor. There is, however, another factor which enters here; that is the volumetric efficiency. If 100 cubic feet of piston displacement of the compressor actually delivered 100 cubic feet of gas measured at the intake pressure, this would be the horsepower per 100 cubic feet, but in this case the volumetric efficiency is 93.7 per cent., or in other words there are 93.7 cubic feet of gas actually compressed and delivered for every 100 cubic feet of piston displacement of the compressor. It is, therefore, necessary to divide our figure 49.2 by 0.937, giving an answer of 52.4 indicated horsepower actually developed in the compressing cylinder per 100 cubic feet of gas actually compressed and delivered from the cylinder per minute, measured at the intake pressure of 51½ pounds per square inch.

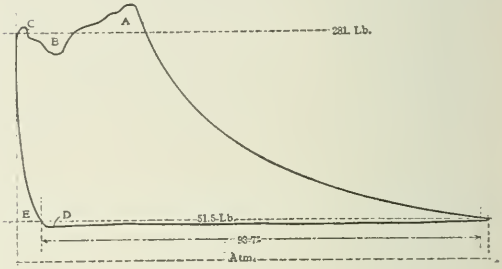


FIG. 2.

Now, as already said, the theoretical power required for adiabatically compressing natural gas from 51½ to 281 pounds is 49.9 indicated horsepower per 100 cubic feet per minute and, therefore, the efficiency of compression will be the ratio of 49.9 to 52.4, or 95.3 per cent. In other words, although as in all good compression work, the compression curve falls below the adiabatic compression line, the excess area of the indicator card as shown above the discharge line at *A* and *C* in Fig. 2 and also the area underneath the intake line at *D* in the same figure, do actually make the indicator card greater in area than it would be if the compression line followed the true adiabatic line and were cut off square at the top along the discharge line and at the bottom along the intake line. The areas *A* and *C*, as said, tend to increase the area of the card, whereas the area *B*, which is due to a pulsation of the pressure in the pipe line, and the area *E*, which is due to re-expansion from the clearance space, both tend to decrease the area of the indicator card and bring it down more nearly equal to the theoretical power required.

In this connection it may be noted that the volumetric efficiency, while it means a decrease in the quantity of gas delivered by a machine of a given size, also means a decrease in the power required to compress this gas by an amount equal to the area *E* shown in the card, and this reduction in area is almost exactly the same as the reduction in the quantity of gas compressed, so that loss of volumetric efficiency means very little loss of power efficiency.

The compression efficiency shown by this particular card is very good indeed, as it is no unusual thing to find this efficiency for some of the poorer grades of compressors as low as 85 per cent. As said, this efficiency depends upon the valve area and speed of the compressor, and it is also very materially affected by the ratio of compression; that is, the absolute discharge pressure divided by the absolute intake pressure, or the number of times that the pressure is increased in the process of compression. The higher the ratio of compression the higher the efficiency of compression, because as the useful power increases, the area of lost work shown on the indicator card bears a smaller ratio to the whole. It is, therefore, important that the efficiency of compression for different compressors should be carefully compared under the same conditions of compression ratio, and also compressor speed.

This is all very well, but what does this have to do with the pulsation diagrams shown as taken from the compressor-discharge pipe? It is just this: The efficiency of compression can be calculated only when the actual discharge pressure is known, and it very seldom happens in a compressor station that the pressure gage reads anywhere near the correct figure. Its error may be anywhere from 1 to 10 pounds, or even more, and it is also usually piped up at such a great distance from the compressor that the reading, even if the gage is carefully calibrated, is not the true discharge pressure of the compressor at the discharge pipe where the compressing cylinder delivers the air or gas.

If, in order to eliminate these losses of pressure drop in the pipe line after the gas or air has left the compressor cylinder, which losses should not be charged against the compressor, the pressure gage is placed on the discharge pipe close up to the cylinder, the pulsations of the gage hand caused by the air pulsations, which we have said so much about already, will make it impossible to get an accurate reading of the true discharge pressure, even if the gage itself is accurate. The only thoroughly satisfactory way to obtain the actual discharge pressure for careful calculation is to put an indicator upon the discharge pipe, as already described, and to take these diagrams of the pulsations in the pipe.

It must be understood that the indicator must be positively driven from the compressor mechanism just as the regular indicator on the cylinder is driven in order that a true diagram of the pulsations taking place with each stroke of the compressor may be obtained. If the indicator string is pulled by hand without regard to the motion of the compressing piston, the diagrams obtained will never be twice alike, and moreover the instrument will not form a closed diagram, which it should, of course, do. The only proper way to do this is, then, to drive the indicator on the discharge pipe from the same source as the indicators on the cylinder, that is, usually from the crosshead.

CALCULATING RESULTS.

After our diagram of the air pulsations has been obtained, how can we obtain the actual discharge pressure? Turning back to Fig. 1 and looking at diagram *A*, we will see at each end of the atmosphere line, a perpendicular erected. Now using a planimeter and starting in, say at *X*, we can follow up the vertical line until it comes to *Y*. At this point continue farther up with the pointer and follow around the upper line, as shown by the arrows, to *Z*, where the other line is crossed. Continue along the underside of the right-hand end of the figure 8 until you come to *W*, and at this point turn sharply down along the perpendicular leading to the other end of the atmosphere line at *V*, and finally back along the atmosphere line to the point *X* where we started. Let us assume that the area thus obtained is 4.05 square inches.

Again starting at the point *X*, follow up the vertical line to *Y* and at this point turn sharply to the right along the lower side of the left-hand end of the figure 8, coming again to *Z* where the other line is crossed. Following along the upper side of the right-hand end of the figure 8 we come to *W*, and from here we go down the perpendicular to the atmosphere line and finally along the latter to the point *X* from which we started. Let us assume that the area thus obtained will be 4.01 square inches. The average of these two areas is 4.03 square inches.

Measuring the length of the diagram we find it to be 2.69 inches. If the average area of the diagram *X Y W V* is 4.03 square inches and its length is 2.69 inches, the average height will be 4.03 divided by 2.69, or 1½ inches. If now a line *Y Z W* is drawn 1½ inches above the atmosphere line *XV*, this will truly represent the average pressure shown by the figure 8 curve, which is, of course, the true average pressure in the discharge pipe. If the scale of the spring is 60 pounds to the inch, this line 1½ inches above the atmosphere line will represent 90 pounds pressure.

This gives an accurate means of calculating the theoretical power to the exact pressure at which the air or gas is being delivered from the compressor and, comparing this theoretical power with that actually obtained by an indicator on the compressing cylinder itself, the true efficiency of compression of the machine may be obtained.

For diagrams such as the others shown in Fig. 1, which are somewhat unusual in their extreme number of vibrations, an easy way to obtain the average height is to traverse the planimeter point along the wavy diagram halfway between the two lines, of course crossing both lines each time the two lines cross each other. This is especially easy where the lines follow each other very closely, as in diagrams *B, D, E* and *F*. Although this method is not quite so accurate as it would be to follow out each separate wavy line by itself, taking an average of the two areas thus obtained as we did for Fig. *A*, a little practice will develop sufficient skill to obtain results in this way just about as accurate as if each line were followed separately.

This average method cannot be adopted in such a diagram as that shown at *A* because, as the lines cross each other at one point only, *Z*, if we are to try to follow the middle line through the figure 8 with the planimeter point, we might as well draw the average pressure line in with a pencil by guessing at it and then measure the distance. Such a procedure, of course, at once destroys all the accuracy that it is desired to obtain by the use of the diagrams and the planimeter instead of the ordinary pressure gage.

This study of the efficiency of compression of various compressors under various conditions of ratio of compression, speed and valve area is exceedingly interesting, and it is a subject well worthy of careful investigation. By this means only can a true estimate be made, with sufficient data at hand, to determine just how much valve area the compressor cylinder should have for a given set of conditions to give a certain efficiency of compression and consequently facilitate the making of accurate guarantees of performance on the part of various manufacturers.—*American Machinist.*

A REFRIGERATING TURBINE

A French inventor has constructed a refrigerating machine of entirely new type. This machine consists of the combination of a steam ejector with a turbine used as a condenser. The steam ejector used with the condenser produces a vacuum over a receiver filled with brine; the water, as it evaporates, produces a progressive degree of refrigeration. The steam jet, as discharged from the ejector, enters a receiving chamber, where the steam passes through a series of converging tubes, which at their outlet end are again made to diverge. Thence the steam reaches the condenser, which is a reversing turbine with the injection of water at the centre. The steam from the ejector, together with that from the brine vessel, which is carried over along with it, becomes condensed in the turbine. A centrifugal pump, keyed on the same shaft as the condensing turbine, causes the active circulation of the brine. The constant vacuum maintained in the receiving vessel helps to draw in brine. The steam pressure at the ejector is 4½ lbs., and in expanding it assumes a speed of 3,900 ft. per second.

RECORDING METER FOR AIR OR GAS VELOCITIES

The accompanying cut, reproduced from Metallurgical and Chemical Engineering, shows the design and principle of action of a recording gage for showing the velocities of flue gases, but apparently applicable also to the gaging of the flow of compressed air in pipes. For the latter purpose, no matter what the air pressure, it would seem that the entire apparatus might be enclosed in a chamber subject to the pressure, and then its action should be the same as when subject to simple atmospheric conditions.

The gas whose velocity is to be measured flows through the flue shown in the right hand and in the direction of the arrow. Within the path of the gas the ends of two pipes, R_1 and R_2, are placed, the ends of both being bent but in opposite directions. This causes a difference of pressure being caused by and being dependent solely on the velocity of the gas, and by measuring this pressure difference the velocity of the gas is determined.

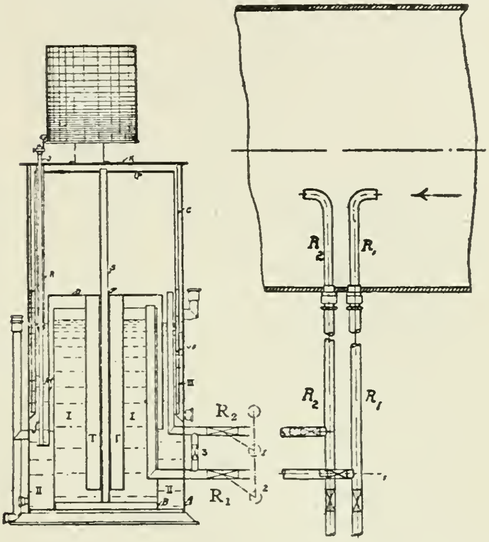
The pressure difference is measured in the apparatus shown at the left. It consists in the main of two cylindrical compartments, one within the other. Both are partly filled with liquids, of which the inner one serves as operating medium and the outer one as a water seal. The inner liquid *I* carries a float *T* to the top of which is fastened an inverted cup-shaped cylinder *D*, which dips with its lower open rim *M* into the outer sealing liquid *II*. In this manner two independent gas chambers are formed, both of varying capacity, depending upon the depth of the immersion of the bell, which in turn depends directly upon the variation of pressure within and without.

A rod *S* that is centrally fastened to the bottom of the main cylinder serves as a guide for the operating bell. Its upper end passes through the removable cover plate *P* of the apparatus.

The movement of the float or bell is carried outwardly by means of a second rod *J*. This rod is hinged to the lower portion of the bell and it passes through a tube *R*. The top end of this tube is secured air-tight to the cover, and its lower end dips into the sealing liquid *II*. The rod carries at its upper end a writing pen which bears against a rotating cylinder operated by clockwork, and this serves to trace the varying differential pressures of the system upon a chart.

An additional water seal *IV* is provided for the cover by a cylindrical portion *C* extending therefrom downwardly into the sealing liquid *III* of an annular space, formed within the upper portion of the main body.

Communication between the gas main and the apparatus is established by two pipes R_1 leading into the air space below and R_2 leading into the space above the movable bell. Each of these pipes is provided with a stopcock, 3, and both cocks are linked together to make them work simultaneously. By these means it is made possible to distribute the pressure to both sides of the bell at the same time. A three-way cock serves to make communication of both air spaces in the apparatus with the atmosphere.



RECORDING GAS VELOCITY METER.

The filling of the three independent liquid chambers is accomplished through pipes which lead out from the main body of the apparatus Plugs are provided for at the lower end of these pipes, which allow easily draining the receptacle if this should be necessary.

The velocity of the gas in the flue causes, as explained above, a difference of pressures in the two pipes R_1 and R_2, and this pressure difference causes the movement of the bell which is transmitted to the writing pen on the recording device.

This apparatus, which is made by the Hydro

Manufacturing Company, Pittburgh, Pa., is designed to be used in gas works, producer gas installations, coke oven plants, blast furnace plants, and in general in metallurgical and chemical works in which the success of the process depends on a definite rate of supply of air or gas. Naturally the instrument is also useful in boiler plants, where it is employed to check the correct air supply for the most economical combustion of the coal; in this case the record chart indicates every operation of the fireman or of the automatic stoker, and serves as a guide to the fireman in which manner to obtain the best results.

EFFECTS OF HIGH TEMPERATURE AND HUMIDITY IN MINES

George J. Young, Professor of Mining and Metallurgy in the University of Nevada, in an interesting paper before the American Institute of Mining Engineers, says that while much has been written about the effects of poisonous and other gases upon the human system, very little occurs in mining literature concerning high temperature and humidity. He then quotes samples of what has been written in this line.

Le Neve Foster says: "In still and saturated air it is hardly possible for men to do continuous work above 90 or 95 deg. F., even when stripped to the waist. At higher temperatures in saturated air the amount of work possible becomes less and less, and the body temperature may rise rapidly, though men accustomed to the heat can bear it much better than others. At temperatures above 90 deg. it becomes difficult to remain even without working. Thus, at a temperature of 93 deg. in still and saturated air I found that, though I was stripped to the waist and doing practically no work, my temperature rose 5 deg. in two hours, and was still rising rapidly when I found it necessary to come out. On the other hand, it is a well-known fact that if the air is dry much higher temperatures can be borne with ease and comfort. In collieries where the air is fairly dry and in motion, men can work well at a dry-bulb temperature of 90 deg., or even 100 deg., and in hot climates with very dry air much higher temperatures are not oppressive."

AS TO PERMANENCY OF EFFECT.

The following is the conclusion of Eliot Lord: "The ultimate effect of this extreme heat on the miners' constitution is not so easily noted. The mine levels differ materially in temperature, and the assigned station of a miner is so frequently changed from one cause or another that it is impossible to obtain at present complete comparative data. That prolonged labor in hot, impure atmosphere will assuredly shorten life appears indisputable; but whether the system is permanently or materially injured by intermittent working under those conditions is more questionable. The power of recuperation appears extraordinary, and unless the strain is intense and frequent no lasting injury may be inflicted. The limits of permissible strain vary with the relative power of endurance. The action of all the bodily organs appears to be stimulated by the heat, with the exception of the stomach alone."

NO LUNG TROUBLES.

Messrs. Haldane and Thomas comment on exposure to high temperatures and to sudden variations of temperature as follows: "Miners are exposed to high temperatures underground and to comparatively sudden cold on coming out, often with damp clothes on. Much stress has been laid upon this fact, particularly in relation to lung diseases. Nevertheless, this cannot be an important cause of lung diseases, for colliers are similarly exposed. Moreover, in England colliers never wash or change their clothes at the pit head, while Cornish miners invariably do so in a heated building (dry) provided on the mine. The effects of high underground temperatures on men and horses are certainly of considerable interest and economic importance, and we know from personal observations that in warm and moist air underground the body temperature often rises several degrees; but we can find nothing in the circumstances connected with the mode of occurrence of miners' phthisis to suggest that high underground temperatures are in any way connected with its causation."

Church states his final conclusions as follows:

"The casualties positively traceable to heat are therefore 12 per cent. of the whole. Probably the heat increases the bad effects of the powder fumes and natural gases, and by making repairs to the shafts more frequently necessary it indirectly adds to the occasions when disasters may occur. I also confess to the belief, which is not sustained by observations upon specific casualties, that some allowance must be made for a less active mental condition, a dulling of the faculties and a certain recklessness to which the heat sometimes goads the men. On the other hand, heat makes them more careful, except when under momentary impulses, and I have never seen American miners more careful of themselves than in these mines. On the whole, the good and bad effects of heat seem to nearly balance each other, and I think that an allowance of 5 per cent. for the casualties indirectly caused by heat would be sufficient."

The main facts brought out by these observers, says the author of the paper, are that high temperatures and humidities cause, under some conditions, a notable rise in body temperature, that all the bodily organs with the exception of the stomach are stimulated, that prolonged exposure to such conditions undoubtedly lowers vitality, that intermittent exposure produces no permanent ill effects, that these conditions cannot be considered an important cause of lung diseases, and, lastly, that under abnormal conditions loss of mental control and serious bodily disturbances result.

Local physicians inform me that the average life of the Comstock miner approximates 25 years, and that the miners do not show any greater susceptibility to any particular disease than the residents of the town. I am acquainted with miners who have worked more or less continuously underground for 30 years, and who are still capable of doing a good day's work. Compared with miners of other districts the Virginia City miners may be said to be just as healthy, if not more so. The result is due in a large measure to the fact that the Virginia City miner observes certain precautions, and that the mine-managements provide the necessary facilities.

MINERS' PRECAUTIONS.

Miners are careful not to expose themselves to cold drafts, since they work stripped to the waist. On passing from a hot to a cold place a heavy coat is used to protect the heated body. Wet clothes are either removed before going to the surface, or trousers and coat worn over them. All miners take hot and cold showers after coming off shift. Frequent drinking, and the bathing of the hands, wrists, arms, and head in ice-water is resorted to in all hot workings, and undoubtedly serves to keep down the body temperature, while temporarily refreshing. Frequent rests are taken in special cooling-rooms, so placed in the workings as to receive the freshest and coolest air. In exceedingly hot workings cold water from a hose is turned upon the miner while at work.

The effect of the underground conditions upon the blood was made the subject of a preliminary study by Prof. P.. Frandsen at my request. His conclusion, given tentatively, is that "the conditions in the deep workings of the Virginia City mines do not have any particularly detrimental effects upon the composition of the blood. It appears that the main permanent effect is an increased hemoglobin content of the individual red-blood corpuscles."

COMFORT AND EFFICIENCY.

Conditions are not favorable for a study of the comparative efficiency of miners working under normal temperatures and under those in the lower levels of the Comstock. The following conclusions are the results of my underground experience.

(1) Moderately high temperatures, from 95 deg. to 105 deg. F., with moderate humidities from 50 to 70 per cent. relative humidity, and with air currents of velocities from 200 to 300 ft. per. min., do not prevent efficient work nor are they particularly uncomfortable.

(2) A higher temperature, from 110 deg. to 115 deg., together with the same conditions as above, decreases efficiency to a considerable extent.

(3) A high temperature, from 110 deg. to 115 deg., with high humidity and a moderate velocity air current, very greatly impair the miners' efficiency, and a still higher air velocity, under the same conditions, renders workings more bearable, but miners cannot work very long at one time.

(4) A moderately high temperature, from 95 deg. to 105 deg., in a saturated atmosphere with no current, becomes very trying. Prolonged exposure with much exertion is dangerous.

(5) A moderate temperature, from 90 deg. to 98 deg., in saturated air currents of a velocity from 400 to 500 ft. per min., and with more or less vitiated air, are conditions which are very trying and give a low labor-efficiency. Vitiated air will impair labor efficiency to a greater extent than a high temperature.

A chair in aerial navigation has been established at the East London College of the London University.

AUTOGENOUS WELDING

A number of trials have recently been conducted with the autogenous welding process at the plate mills of the Schulz Knaudt Company, Essen. The chief advantage of this process is that the joint, if desired, can be made thicker than the rest of the material (plates), so that it will not be the first portion to give way under tension or compression strains. Certain precautions are necessary to the attainment of successful results; the acetylene, for instance, has to be free from any lime dust or other impurities, and the burner must be large enough to ensure that the gas does not issue with excessive velocity, and to prevent working with an excess of oxygen. The added metal must be of the best quality, and the drops should not fall into the joint until the material there has been fused by the burner. In the absence of this precaution no proper weld can be obtained, the adhesion between the metals being only like that between wood and sealing wax. Finally, continuous hammering of the added metal is necessary, and careful annealing of the joint; if possible, the joint should be welded from both sides of the plate.

In testing the strength of joints welded by the autogenus process, no proper criterion can be obtained by taking test bars that have been worked on all sides, especially when the projecting metal at the joint is filed down flush with the rest of the material. If the joint be left untouched, the test piece will break at some other place when the tensile strength of the material is exceeded; but when the joint has been weakened by filing it may break first, contrary to what would happen in practice. Moreover, filing does not improve the elongation, as it does in the case of pieces welded by the water-gas process, where the joint is thinner than the rest of the material.

For the purpose of carrying out the tests in question, a dome-ended boiler, 4 ft. in diameter and 5 ft. long, was constructed of 0.6-in. plate, there being one longitudinal and two transverse joints, all welded by the autogenous process. The finished boiler was subjected to an internal hydraulic pressure considerably in excess of the mean breaking strength of the boiler plate used; but no leakage was produced in any of the joints. The boiler was afterwards cut up, and specimens of the plate and joints were tested, with the result that the weakest worked specimens did not break until a tension of 48,400 lbs. per square inch was reached, as compared with 55,000 lbs. for the plate, and a minimum of 53,000 lbs. for the unworked specimens. The elongation ranged from 6.5 per cent. to 21.3 per cent. for the joint specimens, and from 27.3 to 29 per cent. for the plate specimens.

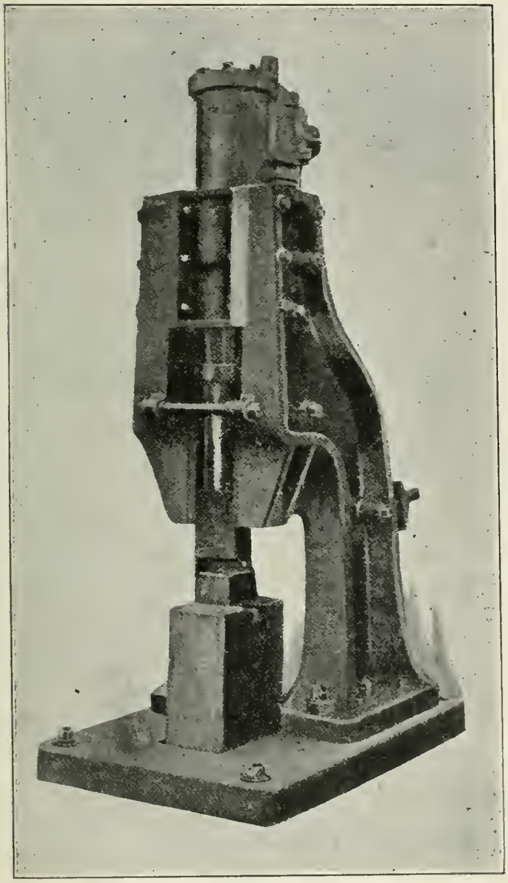
In another series of tests a cylindrical tube, 34 in. in diameter and 40 in. long, was made from 0.4-in. plate with one longitudinal joint. This tube was corrugated on the Fox pattern, made red hot and rolled plain, and then corrugated on the Morison pattern, this giving corrugations in different positions from those produced at first. This tube gave test result quite equal to those furnished by a similar tube welded with water-gas.

AUTOMATIC HIGH SPEED PNEUMATIC HAMMER

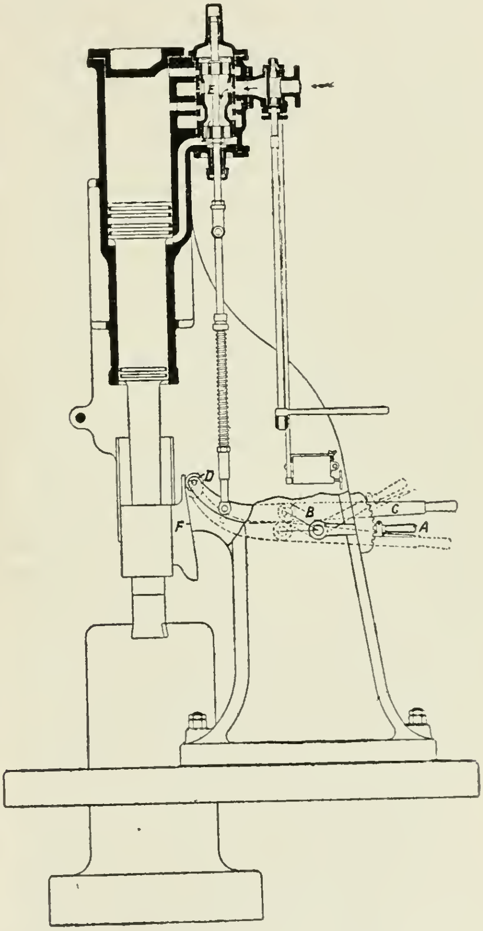
The half tone and the sectional cut here reproduced from *The Engineer,* London, show the essential features of the new development of the pneumatic forging hammer as produced by the firm of Peter Pilkington, Limited, Bamber Bridge, England.

This hammer has been designed in recognition of a demand which exists for a pneumatic hammer capable of working at high speeds and which can be set to run automatically with various strenghts of blow. The principle on which the hammer works is the same as that of the ordinary forge type produced by the same firm and described in COMPRESSED AIR MAGAZINE, October, 1907. The air cylinder is of considerable length, bored out to two diameters, and at the upper end of the tup there is formed a piston head, working in the upper or larger power cylinder, while the smaller cylinder acts as a guide. Air is admitted under the piston into the upper cylinder for lifting the tup only, and this same air on being exhausted is expanded on the top side of the piston for striking ordinary blows. When a heavy stamping blow is required, the operator can utilize the full air pressure on top of the piston. It should be pointed out, however, that for striking dead blows the lifting area of the piston is in communication with the air supply, as well as with the space on top of the piston, or, in other words, both sides of the differential tup are in communication with the air supply.

In the ordinary pneumatic hammer made by this firm there is only a single operating lever, which serves for all strengths of blow, light or heavy, and also for holding up or down. In the high-speed type illustrated there are provided two levers, one to give the time blow, and the other to fix the automatic blow for any degree of intensity. The self-acting motion consists of the quadrant lever A, which is rigidly connected to a crank or movable fulcrum pin B. This supports another lever C, carrying a roller D at the end, which also operates the piston valve E. When the quadrant lever is in its lowest position—shown in full lines—the movable fulcrum pin will be in its highest position, so that when the air pressure is turned on the tup will rise, and the lever carrying the roller will also rise on the inclined slide F. The piston valve will thus be raised, allowing the air to flow to the top side of the piston, when the tup will be driven downwards. This cycle is repeated automatically so long as the air supply valve is open. When, however, the quadrant lever is moved to its highest position—shown in dotted lines—the fulcrum pin is brought to its lowest position, and this lowers the lever and the piston valve. In this case the air is again admitted to the lower side of the piston, and the tup rises to its top position; the inclined slide again lifts the lever and valve, but, since the latter was lowered by the quadrant lever, the valve will not be raised to the same height as previously, and the port to the top of the piston will re-



AUTOMATIC PNEUMATIC HAMMER.



SECTION OF CYLINDER AND VALVES.

main closed. The tup therefore remains in its highest position. When it is desired to operate the hammer by hand, or to strike dead blows, it is only necessary to operate the hand lever C, and thus move the valve, the quadrant lever in the meantime being fixed in its highest position. The force of the blow when the hammer is working automatically is thus regulated by varying the position of the quadrant lever.

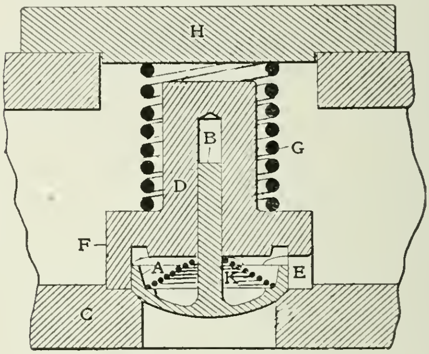
Attention should be called to the method of securing the cylinder between the two standards, the cylinder being provided with two keys, which form part of the cylinder flanges. These keys fit into corresponding recesses in each standard, and take the shear off the bolts which hold the parts together. This type of hammer is made in sizes varying between ½cwt. and 7½cwt., and the number of strokes per minute varies between 300 in the smallest to 150 in the largest sizes.

A COMPRESSOR DISCHARGE VALVE AND A CRITICISM

Those unfamiliar with compressed air practice, and especially with the compression of the air, cannot be expected to appreciate the complexity of the problem or the multiplicity of conditions, many of them apparently conflicting, to be satisfied, or often rather to be compromised or reconciled, to secure the best results. Great progress in compressor design has been made in the last score of years and the study of compressor details is as active as ever. Among the most responsible details of the compressor are the discharge valves, and valves in great number have been devised and successively tried and the work of promoting the survival of the fittest still goes on.

A new discharge valve for air compressors, the invention of Mr. C. A. Dawley, is shown in the cut and we abstract here some of the descriptive matter, presumably written by the inventor himself, with which the valve was presented to the readers of *The Engineering and Mining Journal* in a recent issue. It is suggested that compressors should be run much faster and it is asserted that "the expert on compressors will tell you that the cause of the speed limitation in all sizes of air compressors, except the very large ones, is due to the sluggish action of the discharge valves." Then follows the description of the new valve which should be capable of more rapid action.

"A" represents the valve proper; *"B"* is a small guiding stem which serves merely to steer the valve in its motion; *"C"* is the seat or portion of the cylinder in which the valve rests; *"D"* is the guide for the valve and stem and also serves as a stop for the outward motion of the valve; *"E"* is one of a series of ports in the circumference of the guide; *"F"* is one of a series of legs which come between these ports and center the guide upon the seat; *"G"* is a heavy spring which is intended only for holding the guide down in its place without the necessity of making a rigid connection between the guide and the cover *"H."*



DAWLEY DISCHARGE VALVE.

It will be observed that the diameter of the grinding portion of the valve is considerably in excess of the diameter of the opening which is the nominal size of the valve. It will also be noted that the valve is very light in weight because of the fact that the guiding portion is short. This guiding portion does not need to be of any greater length because the valve is held to its proper direction by the stem *"B."* In operation the top edge of the valve guide passes back and covers the edge of the ports *"E"* in the guide. Whatever air is between the valve and guide at this point is thus inclosed and acts as a cushion to bring the valve gradually to a stop, and this in turn builds up a pressure back of the valve which assists in returning it to the seat. The spring may consequently be light and the resistance to the flow of the air through the valve is very little. This valve operates almost noiselessly and is capable of a high rotative speed.

The usual speed of compressors ranging all the way from 4 to 24 in. stroke, does not exceed 150 r. p. m. With this valve, however, there is no reason why compressors should not be operated up to piston speeds corresponding to those used in steam engines. These valves have been tried out under severe conditions and have proved themselves highly satisfactory. The advantages of this type of valve may be summarized as follows:

Operating Features—(1) Lightness in weight without reduction of strength. (2) Large area of cushion compared to the opening area. (3) Valve guided close to seat. (4) Opening cushioned, making the action of valve free from vibration and pounding. (5) Rapidity of action.

Features of Construction—(1) Valve can be made from a drop forging and submitted to proper heat treatment, then the stem hot-riveted in, and the entire valve finished by grinding. This makes the best as well as the cheapest method of manufacturing. (2) No necessity for perfect alinement between valve cover and seat. (3) Valve cannot be displaced from its seat by distortion due to heat or pressure.

Such a publication as the above of course challenges criticism, and in this instance it was supplied in a later issue of the same publication by Mr. S. B. Redfield. He says:

An essential for an air-compressor discharge valve is that it shall have plenty of guiding surface. The valve shown in the cut, accompanying the article referred to, is exceedingly lacking in guiding surface, as it must depend for this upon the guiding pin *B* in the center and the rim of the valve lip.

An examination of modern valves made by first-class manufacturers will show guiding surfaces three, four or more times as great as given by the design under discussion. This is accomplished by a cylindrical sleeve of large diameter replacing the guiding pin. Furthermore, another essential of the efficient discharge valve is to have free air passage around the rim of the valve. Such construction as the alternate ports and grids marked *E* and *F* in the cut, serves to defeat this, especially if the grids are of any appreciable width. If they are not of any appreciable width the so-called "guiding portion" around the lip of the valve is just that much cut down. Also with narrow grid bars it is easy to imagine a tendency to wear the valve lip in ridges, thus quickly removing any guiding tendency on the part of the grids.

As shown in the cut, it would also appear that the valve spring, which is of conical form, is altogether inadequate. A successful spring, to stand the strain of long and continued air-compressor service, must have more length than would be possible with the construction shown to give enough elasticity, and also greater wire gage to have the proper stiffness.

Next, the claim made for the valve in question that there is effective cushioning above the lip of the rim is rather weak, for this cushioning does not take place until the lip has been lifted up above the top of the ports and begins to enter the shallow pockets in the guide block. The motion after this time is very limited and it is hard to imagine any effective cushioning, especially with the large clearance volume between the valve and guide block. There is, however, some cushion in the chamber *B*, but this chamber is small and without relief to the outside air, so that if the valve were ever positively opened all the way, it would either be against great pressure in *B* or else the air would have to be squeezed out of this space. This squeezing out would tend to hold the valve open due to the vacuum formed by the next downward movement, resulting in delay in the closing of the valve. This effect would be most undesirable, as may be imagined.

Such a suggestion as to make the valve in two parts, that is, by hot riveting the stem in place in the main body of the valve, is extremely questionable. Any valve made in two parts and held together by riveting is practically certain to break apart in a short time. The severe pounding received by these valves in their every-day, continuous operation is more than such construction would stand. First-class manufacturers in these days are cutting their valves from solid material in order to do away with just this feature.

Comparison of weights with effective areas proves nothing unless it is found that, running side by side in actual practice, the new valve will last as long as the heavier valves with which it is compared. Anybody could make a valve which would be extremely light, as this simply means cutting away more metal. The question is, however, how long will it stand the pounding?

The dividends declared by the gold mining companies of the Transvaal for the year 1909 amounted to $47,000,000.

THE AIR LIFT IN A SOUTH AFRICAN MINE

B. C. Travers Solly at the July meeting of the Chemical, Metallurgical and Mining Society of South Africa described a simple air-lift pump used in the May Consolidated mine for unwatering flooded winzes. A two-inch delivery pipe was used, a one-inch air pipe being strapped to it. The air pipe was bent sharply at the bottom and entered the delivery pipe for a distance of three feet. The end was flattened to split up the air currents, giving the greatest possible aeration of the water. The arrangement started with an 18-ft. length of delivery pipe with a bend and short length attached to the top, and as the flow of water decreased fresh lengths were added until the necessity for its use in the winze ceased. The lift at this stage was through a slope distance of 52 ft. in a 40-deg. winze when the surface of the water was 11¾ ft. above the air delivery. The rate of delivery at the start averaged 600 gal. per hour and decreased gradually as the distance between the surface of the water and the air jet diminished. Very little air was required at first but the consumption increased as the water fell. The lift was then moved to another winze and similar results were obtained. The winze was down only a short distance and some one having forgotten to turn off the air one night the water was lowered to a distance of 26 ft. below the discharge of the delivery pipe and only seven inches above the air jet. The apparatus was still at work delivering water in a spray. This describes simply a handy rather than an economical air lift, or, rather, the economy was in the handiness instead of in the actual air consumption.

STANDARDS OF WATER PURITY

A City Council in Oklahoma advertised that the city's spring water was 98 per cent. pure. This would be 20,000 parts of impurity per million. Another city went into the papers with the bold statement that its purifying system was furnishing water that was 98½ per cent. pure. Think of it. Only 15,000 parts impure per million. The absurdity of these boasts may be illustrated by reference to the Steelton (Pa.) water-works. The water there is so filthy that they filter it through coal slack before allowing it to go to the sand filters and yet its maximum turbidity is only 1,600 parts per million. Our city officials in Oklahoma were simply boasting that their water was not more than 9 to 13 times as bad as the very bad water at Steelton. They may learn some day that water that is not at least 99.99 per cent. pure is nothing to brag about.—*H. V. Hinckley, Retiring President of the Oklahoma Engineering Society.*

A NEW EXPLOSIVE

An account of a new explosive, the invention of an Englishman, has been given out by Vice Consul General Claude E. Guayant of Panama.

The inventor's exhaustive tests before the members of the Isthmian canal commission and officials of the republic of Panama, showed that it is absolutely impossible to explode it by ordinary means. It was hammered with a sledge, shot into with a rifle, burned and ordinary dynamite detonators were exploded in it, both by fuse and electricity, but the compound was inert. Not until a special detonator was inserted could the substance be exploded; but then, in a few charges that were set off, it showed itself more powerful than dynamite. It can only be set off by heating a small platinum wire just inside the open end by an electric spark or fuse. It will not explode by concussion. The new explosive is composed of perchlorate of ammonia, nitrate of soda and several other ingredients, such as paraffine, for water proofing, etc. It is claimed that it is 50 per cent. stronger than the 60 per cent. grade of dynamite, and that the cost of manufacturing will be more than $20 a ton cheaper.

COST OF AIR NITRATES

Calcareous nitrogen containing twenty per cent. nitrogen costs for its production from $47.27 to $55.15 per short ton. This makes the actual nitrogen in the compound cost 11.8 to 13.6 cents per pound, while the cost of the nitrogen in compounds formed by the direct combination of the elements in the air is generally conceded to be less. The experiments made with fertilizers of either system, in comparison with Chilean saltpeter, are generally favorable to the artificial product. In sandy soil the calcium nitrate formed by the direct combination of the elements in the air brought even better results than the Chilean saltpeter.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

Established 1896

W. L. SAUNDERS, - - - - - Editor
FRANK RICHARDS, - - Managing Editor
L. I. WIGHTMAN, - - - Business Manager
H. L. KEELY, - - - - Circulation Manager

PUBLISHED BY THE

Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. FEBRUARY, 1910. No. 2

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THE INTAKE PRESSURE IN-AIR COMPRESSOR CYLINDERS

The following correspondence is entirely self-explanatory and should be read with interest. It gives a new start in the discussion of the above topic.

Editor Compressed Air Magazine:

Referring to your December issue and to the reprint of my letter to you regarding the intake "ram" effect, I wish to say that the word "with" on the last line but one should have been "without," as you suggest; it was an oversight in writing.

Noting your suggestion that I might be able to make reply to the questions I proposed, I offer the following which I think is simple enough and leaves out complicated mathematics.

Assume a cylinder of 300 square inches area and 4 foot long and piston speed of about 500 feet per min., so that the maximum piston velocity is 16 feet per sec. Assume a piston inlet pipe 7 inch diameter and 5 feet long such that its content of free air weighs 1-10 of a pound, avoirdupois. The mass of air weighing 1-10 of a pound in this piston inlet pipe while moving at 16 feet per second contains an amount of energy expressed by $\frac{Mv^2}{2} =$ 4-10 of a foot lb. Inasmuch as it will take very nearly 1200 foot lbs. to raise the pressure in the given cylinder to 1 lb. gage we will make no great error in assuming that 4-10 of a foot pound will raise the pressure 1-3000 of an inch. This being a microscopic proposition it could not be measured by an indicator and therefore the explanation of the phenomenon you speak of must be sought elsewhere.

E. A. Rix.

San Francisco.

A copy of this letter was submitted to the writer below, with the result here given.

Editor Compressed Air Magazine:

Your letter of the 3rd inst., together with inclosures, has been received and it has given me great pleasure to study over this matter of the inertia of air entering the inlet pipe of an air compressor cylinder.

From my remarks, made upon other occasions, you know that up to this present I have strongly doubted the inertia theory of accounting for the rise in the intake pressure line of an indicator diagram of an air compressor and so you will be surprised to find that since I have been studying on this problem the figures which were deduced from such study have caused me to completely change my opinion and to believe that inertia of the air column is responsible for the phenomenon.

First, to take up the problem which Mr. Rix presents, you will note that he considers the air in the inlet pipe to be moving at 16 feet per second. This corresponds to 960 feet per minute as a maximum speed, or assuming an infinite connecting rod this should be the speed of the crank pin in its orbit. With a 4 foot stroke the crank circumference will be 12.6 feet and so, dividing 960 by 12.6 we have 76 r. p. m. of the compressor, which is a reasonable speed for the size machine considered. Now, however, Mr. Rix has assumed that the air is moving through the inlet pipe only at this speed, whereas that is really the maximum speed of the piston at about mid stroke.

Suppose we assume that the inlet area is 12 per cent. of the cylinder area; this would give a speed of the air through the pipe eight times as fast as the piston speed at any point, and as from the formula for inertia as given by Mr. Rix, this depends upon the square of the velocity, the kinetic energy of the moving air should really be 64 times as great as that given. 64×0.4 gives an energy of 25.6 foot pounds for the quantity of air considered in the inlet pipe.

Apart from this Mr. Rix has considered an inlet pipe only 5 feet long. It seems to me that 15 feet would be more reasonable, wherefore, multiplying by 3 we have 76.8 foot pounds, as the probable energy of this air.

Now to turn to another method of figuring this inertia. You know that many writers on engine design give formulas for figuring the net force for starting and stopping the reciprocating parts at the beginning and end of each stroke. Most of these writers give these results for an engine with an infinite connecting rod. Under these conditions the formula for the starting and stopping force is as follows:

$$F = \frac{W \pi^2 N^2 R}{900\ g}$$

In this formula W is the weight of parts in pounds, N is the number of revolutions per minute, R is the crank radius in feet, g is the acceleration of gravity, or 32.2.

Further study of this problem will reveal the fact that this force is the same as the centrifugal force which would be exerted by an equal weight of material, revolving on the crank pin at the speed given. An explanation of this is given on page 226 of Charles T. Porter's Treatise on the Richards Steam Engine Indicator. It will also be found in other books on engineering.

If the finite length of the connecting rod is taken into account it will be found that this starting and stopping force of reciprocating parts is even greater than given by this formula. Professor Jacobus, in the transactions of the A.S.M.E. Vol. 11, page 492, and 1134 gives factors by which various lengths of connecting rod may be taken into account. If the rod is equal to five cranks, the force calculated by the above formula would be multiplied by 1.2, so that by this you see we are on the safe side if we use the formula for the infinite connecting rod.

Now going back to our original problem: with 3/10 of a pound of air in an intake pipe 7 inches in diameter by 15 feet long and letting the 4 foot stroke compressor be making 76 r. p. m. and substituting in the above formula we find that the force exerted at the beginning and end of the stroke by this air is 1.18 pounds. This does not seem unreasonable when we consider the swinging of a weight of 3/10 of a pound on the end of a 2 foot string, at the rate of 76 revolutions per minute. We can easily imagine the pull would be about one pound, as calculated.

So far we have assumed that the air in the inlet pipe is moving only as fast as the reciprocating parts of the compressor, but, as before, assuming a 12 per cent. inlet area the air will travel eight times as fast. This can be taken care of in the formula by assuming simply that the crank radius is eight times the real radius. This is perfectly logical when it is considered that the horizontal component of the speed at the end of the longer radius at every instant will be just eight times the horizontal component of the speed of the shorter radius, each passing through zero at the end of the stroke and reaching a maximum at the centre of the stroke. Also, the number of reciprocations is unchanged.

As the formula gives the inertia force as directly proportional to the radius of the crank arm, increasing this crank arm by 8 will multiply the force by 8, and consequently we have the inertia force due to the 3/10 of a pound of air as equal to 9.44 pounds for the entire quantity of air contained in the inlet pipe.

It will be remembered that the inlet pipe is seven inches in diameter and this force is distributed over this whole area of 38.5 square inches. Dividing 9.44 by 38.5 gives 0.245 or just about ¼ pound per square inch pressure exerted by this air in the inlet pipe at the beginning and end of the stroke. This result seems to check very well with most of the indicator diagrams which I have seen showing this rise in pressure.

From the above is meant that a quarter pound above the atmosphere is as much as is ever seen; of course it may be argued that the total rise from the intake line is much more than this. This may be easily accounted for by reasoning that as the piston slows up at the end of the stroke, the moving air catches up with the piston and by the time the piston comes to rest, even if there were no inertia, the pressure should be approximately atmospheric, if sufficient valve area were allowed.

Such an inertia effect at the end of the stroke should also be visible at the beginning of the stroke; and what is a more plausible explanation of the decided hook in the clearance expansion line at the point where the intake valve opens, than the inertia of the air in starting into the cylinder?

Many people lay this hook to the inertia of the indicator parts, and no doubt some of it can be laid to that cause, however, I am firmly convinced that inertia of the air has much to do with it, because of some indicator diagrams taken on the very low pressure Post Office compressors in Philadelphia by myself. There, an eight pound spring was used, and, although the drop of the indicator pencil was only about half an inch maximum and the mechanically moved inlet valve was wide open, as determined by actual inspection, a hook of two or three pounds drop at the beginning of the suction stroke, absolutely could not be eliminated. There seemed to be no explanation for this except an air pulsation produced by inertia only.

It may be contended that even after we have re-figured Mr. Rix's results, giving 76.8 foot pounds of energy present in the air in the intake pipe and remembering that, as he said, it will require 1200 foot pounds to raise the pressure of air in the cylinder to one pound pressure per square inch, or about 300 foot lbs. to raise it to one-quarter of a pound per square inch, there does not seem to be enough energy present in the moving air to account for the work done.

A plausible answer to this would seem to be that the air in the pipe is flowing and more air is continually coming in from outside, this air having energy of velocity added to it by the steam engine of the compressor itself. This energy is given up to the air inside of the cylinder during all the time that the piston is slowing up toward the end of the stroke and therefore more energy in foot pounds is actually delivered to the air inside the cylinder than is represented by the volume of the intake pipe only.

It may further be contended that this argument could be applied to the formula giving the force of retardation, as worked out. This is true, but this would not change the force. The pressure would still be one-quarter of a pound per square inch at the end of the stroke, and the fact that the air has been flowing into the cylinder with gradually increasing pressure, up to the maximum of one-quarter pound per square inch, would account for the performance of the relatively large amount of work performed upon the air, this being the product of force and distance.

It certainly must be conceded that as the actual force is shown to be present simply from the reasoning of accelerating force alone, as applied by enginering calculators to the force of the reciprocating parts, the air in the cylinder will yield to this force and build up a pressure equal to it to resist its action, the energy to do the actual work coming from the volume of air flowing through the pipe during the latter half of the stroke.

This explanation is rather long, but by this course of reasoning my own ideas of the subject have been so completely reversed that no shorter line of reasoning would seem satisfactory.

Thanking you for this opportunity to think over this matter and to express my opinion on the subject.

S. B. Redfield,
Associate Editor American Machinist.
New York City.

MEASURING THE FLOW OF COMPRESSED AIR

One of the things at present most to be desired in compressed air practice is some practical and reliable system or apparatus for measuring the volume of air during transmission. We can ascertain both pressure and temperature with any desired accuracy, but the volume during transmission is more elusive, while upon it. in connection with the others, depends all accurate knowledge of capacities and efficiencies, and also of the rate of consumption and ultimate costs of operation in different lines of service. Contributions to our stock of knowledge in this field are accumulating and they are all to be welcomed. In our present issue is described an apparatus intended primarily for the measuring of the flow of flue gases, but apparently applicable also to compressed air, and now we are able to present a statement furnished us by Mr. W. F. Gillies. El Paso, Texas, of certain experiments made by Mr. Legrand, mechanical engineer for the Phelps Dodge interests, at the Copper Queen, Arizona, Mines.

Mr. Legrand has devoted several months to a series of interesting experiments in the measurement of the flow of air through an orifice. He has been testing Flieguer's formula as to its correctness for large volumes. He first with a small compressor proved it up to 1,100 cu. ft. of free air per min., and has since tested it up to 4,000 cu. ft. with a larger compressor, and with a still larger compressor available he is planning to test up to 6,000 cu. ft.

His method is as follows:

1st. Knowing the clearances of the low pressure or intake cylinder he calculates, the actual piston displacement, or the free air capacity of the machine.

2nd. He takes indicator cards of the low pressure cylinder, using a light spring, generally four pounds, and measures the actual volumetric efficiency as closely as possible.

3rd. He tests the pipe line to the receiver and the receiver itself for leakage.

4th. Calculates the weight, or volume, of air passing through his orifice by means of his formula.

5th. Checks 4 by 1 and 2.

The formula used in Flieguer's, to be found in Peabody's "Thermodynomics", and is as follows:

$$\text{Wt. of air per min.} = .53 \text{ area of orifice } \sqrt{\frac{P}{T}}$$

P=Abs. pressure.

T=Abs. Temperature.

The orifice, made of brass and polished, was rounded on the side on which the air entered, the radius being equal to the radius of the opening and the length being twice the diameter. The first tests were made with a ¾-in orifice, but in the last test a large one, 1.05-in. dia. was used to show whether the constant .53 held true for other diameters.

The tests of the smallest compressor up to 1,100 cu. ft. checked to within 1 per cent. to 1½ per cent. The following figures will show how near the results obtained on the larger volumes worked out:

No. of Test.	Size of Orifice.	No. of Orifices.	Cu. ft. Free Air Displaced.	Cu. ft. Free Air Delivered.	Volumetric Efficiency by Card.	Volumetric Efficiency by Orifice.
1	¾"	1	1401	1251	94.7	89.3
2	¾"	2	2438	2212	93.8	90.7
3	¾"	3	3513	3217	93.7	91.5
4	1.05"	1	3555	3256	93.7	91.5
5	2-¾" and 1-1.05"	3	4328	4017	94.5	92.8

The air pressure in the receiver was held at between 100 and 101 lb. gage.

It is thought, and the indicator cards show, that there was some leakage back through the discharge valves. This would account for the decrease of difference between the two volumetric efficiencies as the speed increased, and this matter is to be further investigated. The considering in this way the air discharged takes into account all losses due to leakage, the heating of the air entering the cylinder, etc., and the results seem to agree very closely.

SOUTH AFRICAN ROCK DRILL RECORDS

The following records of rock drill work were made on the Rand, South Africa, the figures being taken from the published statistics of the Mines Department: At the Van Dyke Mine in November, 1908, two 3¼-in. drills drove 323 ft. in 62 shifts of 9½ hours each. This work was performed by two miners named Karlson and Kerr. One white man and five natives worked each shift using two Ingersoll-Sergeant drills. At the New Modderfontein G. M. Co., Messrs. Corris and McHenry, with two 3¼-in. Ingersoll-Sergeant drills, drove during May 267 ft., June 264 ft., and July 295 ft., a total of 826 ft. for 156 consecutive shifts. This was a record for consecutive working. At the same mine, in a 11x8-ft. cross-cut, Mr. Langridge, with two 3¼-in. Ingersoll-Sergeant drills drove 270 ft. in 49 single shifts.

KEEP UP THE PRESSURE IN YOUR TIRES

Automobile experts are quite well agreed that if the riding is easy over rough places and there are no complaints from the occupants of the tonneau because of the jarring then the tires have too little air pressure. If tires are allowed to run continually in this condition the total service may be not more than one-half what it would be if the tires were kept pumped up hard.

"It is simply this way," 'said James A. Braden of the Diamond Rubber Company recently: "a tire is composed of three parts—the casing or shoe, the inner tube or air chamber and the air itself. We make casings and tubes the very best our twelve years of experience have taught us, but the air must be supplied by the tire user.

"It is a liberal estimate to say that the tire kept well inflated will give twice the service of one allowed to run soft and insufficiently pumped up, though I will grant the softer tires ride more easily. Air gauges are all right, but rules as to pressure fall short of producing the best results if they do not make the tire so hard and firm that there is no noticeable flattening when, with all passengers aboard, the car is ready to start."

MOVEMENTS OF DUST PARTICLES IN AIR

Mr. C. H. W. Biggs in a paper before the Society of Engineers says that one of the most interesting investigations, and one open to every student, is that of the effect of minute air currents upon dust particles. Imagine for a moment dust particles having very large surface compared with their mass. Fortunately, the student can on occasion easily see such particles, and watch their evolutions, in a room where otherwise it is almost, if not quite, impossible to detect air currents by other means. Smoke consists of small particles of matter, and is in daily use to detect minute currents of air both in drains and in rooms. There is an excellent way to investigate and to follow the motion even of individual particles. Dr. Travis, in his experimental work on seeing colloidal matter, makes great use of the ultra-microscope. You can get something of this effect in rooms where a window faces a bright sun. Darken the room, leaving only a hole—preferably circular—through which to get a beam of bright sunshine. Thus we get a cone of brilliant light through the room. In this cone you can see dust particles playing all manner of antics, some falling, some rising, some going in one direction, some in another, the direction of the small masses being the direction of the resultant of the forces acting.

THE LATEST THING IN SAFES

The oxy-acetyline blowpipe may be heard of before long as doing wonders in the hands of safe crackers, and in anticipation of this a new burglar proof safe has been invented in Germany on the carousel or merry-go-round principle. It is a polygonal steel structure mounted to rotate upon ball bearings. It is built into a wall and when the outer door is closed an electric motor is set in motion and the safe turns continually and noiselessly on its axis within, any interfering with its movement causing a bell to ring. So long as the safe continues to rotate the blowpipe can have no effect upon it, as the flame is not applied long enough upon one spot to make an impression.

ELIMINATION OF DUST

A French inventor has devised a scheme for freeing the air in a room from floating particles and microbe-laden dust. A ventilator fan run by electricity turns in a large open Cylinder. Above this is a reservoir holding about a gallon, which can be regulated to let out about a quart per hour. The liquid falls drop by drop on the fan blades. It is then, by the rapid turning of the fan thrown out in spray against the cylinder. This spray is condensed in drops containing the microbes and dust. As a liquid the inventor employs glycerine, or soap suds, but the plan works very well with ordinary water. The process can be applied to the chemical purification of air, by using suitable chemical solutions for the liquid. The number of microbes contained in water thus collected in the laboratory of the inventor was 100,000 in three hours. The quantity of organic matter per hour was 0.3 grains and of mineral matter, 0.077 grains.

LOCATING AND CURING A COMPRESSOR TROUBLE

The chief engineer of a large plant discovered, upon starting an air compressor which had been idle for some time, that it would only compress to 20 lbs., which was 60 lbs. below the required pressure. After a few futile attempts had been made to remedy the trouble, the manufacturer was notified by wire to send an "expert." In order to appreciate the situation a brief description of the construction is necessary. The machine had two single-acting air cylinders, the plungers of which were connected to the ends of a piston-rod common to both, which passed through the steam cylinder located midway between the two air cylinders. The inner ends of the air cylinders were open, exposing the plungers. One suction and one discharge valve was used for each cylinder. The suction valves were located in the centers of the plungers, and the discharge valves, which were slightly larger in diameter than the bore of the cylinders, covered the outer ends of the latter. The counterbore into the bottom of which each discharge valve seated, was sealed by the cylinder head. A cylindrical projection on the back of each discharge valve, was a sliding fit in the head, and served to keep the valve in position as it moved back and forth. In order to insure a pressure of one atmosphere in the cylinder at the beginning of the compression stroke, three small holes were drilled through the cylinder wall, just ahead of the plunger when it was in position. As these holes were uncovered just before the end of the suction stroke, an inrush of air occurred, the magnitude of which depended largely upon the stiffness of the closing springs for the suction valves. When the manufacturer's "expert" arrived and the compressor was started, it was very noticeable that instead of an inrush of air through the holes of one cylinder, there was a strong discharge to which attention was attracted by the sound emitted. This indicated at once that the cylinder was in communication with the receiver, and it was also evident that the discharge valve was either broken or displaced. When examined it was found to be rusted fast to the head in an open position. Less than a thimble of oil jumped the pressure to 80 lbs., much to the discomfort of the chief engineer.—*Machinery*.

ILLUMINATING GAS POISONING

The poisonous properties of coal-gas are generally attributed to its content of carbonic oxide, especially as no other substance of known poisonous properties has been found in it, and patients suffering from coal-gas poisoning show the symptoms associated with the inhalation of carbonic oxide, including the peculiar bright red color of the blood. From experiments, made by Dr. von Vahlen, at Halle, it seems probable that we must revise this view, for on making experiments with frogs, animals particularly resistant to carbonic oxide, it was found that they were poisoned far more rapidly by coal-gas than by the corresponding amount of the oxide. Other experiments with dogs showed that the poisonous effect of coal-gas was twice or three times as great as that of the carbonic oxide it contained. Evidently there is some other constituent of coal-gas which is poisonous, though what it is cannot yet be stated. Merely removing the carbonic oxide from coal-gas will not suffice to render it non-poisonous.

NOTES

As an example of the rapidity with which the air brake equipment is undergoing change, it is noted that 70 pages of the Proceedings of the Air Brake Association's 1909 meeting were used in describing a new engine equipment that is already superseded by one of an entirely different type.

A German inventor has recently patented a device for milking cows, in which the flow of milk is to be promoted by subjecting the animal to a "slight electric shock." Of the success of the device in practice we are not informed. A jet of compressed air judiciously directed should have some effect on the poor cow, especially in fly time.

A great chemical factory at Höchst on the Main, Germany, exhibited a new metal at the Frankfort aeronautic exposition that is said to be as strong as the best aluminum alloys and but half as heavy. It is called "elektron" and has a specific weight of 1.8 as compared to 2.9 of the best aluminum.

In a recently invented voltmeter, permitting the measurement of tensions up to 200,000 volts, air compressed to fourteen atmospheres constitutes the insulation, as oil would not be suitable for currents of such high pressures. The tension necessary for perforating a layer of air compressed to fourteen atmospheres is stated to be 400,000 volts per centimetre.

The Italian Government is having installed in each of the cities Rome, Naples and Milan, a system of pneumatic dispatch tubes to connect the railroad station, stock exchange, and general postoffice. Each of the installations is to be operated by electric motors and air compressors, a duplicate power plant being provided in every case to act as a standby. ..

Notices have been sent to the gas companies of the State of New York of a conference to be held in Albany to consider the necessity for a new standard in measuring the quality of gas. The quality is now measured by the photometric standard, by which gas is judged for its illuminating power. This standard has been in use for years. The conference may lead to the adoption of a calorific standard instead.

A French chemist has determined that one ton of dry peat will yield 41 gallons of pure alcohol. After the peat fiber is hydrated it is treated with sulphuric acid and is thus changed into a sort of sugar which when permeated by means of a special yeast yields alcohol. The cost of this method of production is said to be about one-quarter that of potato spirits, so that our large supply of peat may lead to a cheap source of alcohol production.

The total volatile matter in a cubic foot of coal is estimated to weigh 26 lbs.; in this estimate the coal gas is figured at 10 lbs. If steam and air are passed over the 54 lbs. of coke in a producer-gas retort, the result is to generate 4,122 cu. ft.. of producer gas. It is further estimated that 1 ton of coke 90 per cent. carbon, yields 171,000 cu. ft. of producer gas. Acetylene gas is made by fusing the coke with lime in an electric furnace. By this means calcium carbide (CaC^2) is formed.

Germany is to hold an International Congress of Mining and related subjects in 1910. The meeting will be at Düsseldorf, June 20 to 23, and the program is to include discussions on mining, metallurgy, applied mechanics, and practical geology.. Americans are cordially invited to take part. Particulars may be learned from Dr. Schrödter, secretary of the Verein Deutscher Eisenhüttenleute, or Bergassessor Loewenstein, secretary of the Verein für die Bergbaulichen Interessen im Oberbergamtsbezirk Dortmund.

The equivalent volume of free air corresponding to a given volume of compressed air, at the same temperature, and under any pressure may be determined from the following formula:

$$V = V_1 (0.068p + 1)$$

where

V = volume of free air,
V_1 = volume of compressed air,
p = gauge pressure in lbs. per sq. in.

It is here assumed that our atmosphere = 14.7 lbs. per sq. in., and the constant 0.068 in the above formula is the reciprocal of this.

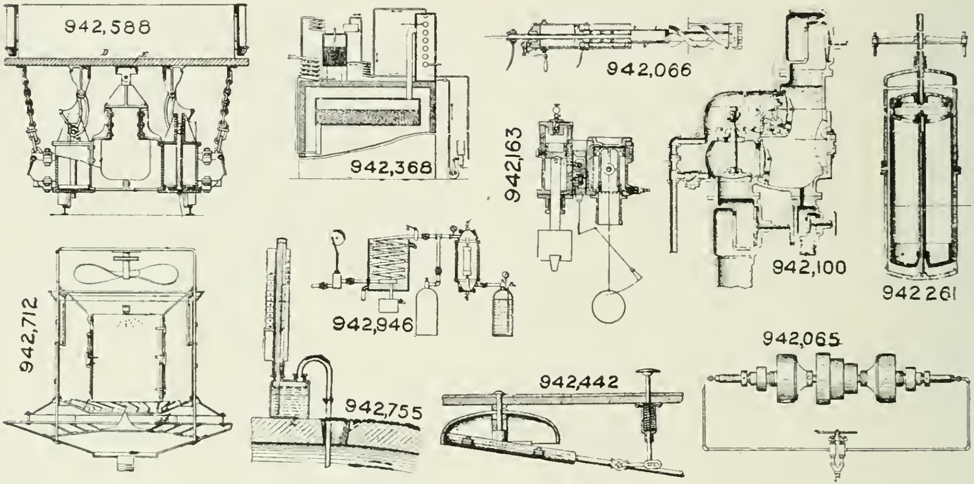
A gas holder built by the city of Hamburg, Germany, at a cost of $3,500,000 and containing 7,000,000 cubic feet of gas, burst recently and the gas it contained ignited. Seventeen persons were killed and 40 were severely injured. The explosion shook the whole city, and a column of fire blazed hundreds of feet skyward, while huge flames played around the reservoir and neighboring structures. There was no possibility of the workmen escaping. Many of them were killed outright, and others were horribly burned. Three women attendants of the canteen are among the killed. The fire burned dangerously for three hours, during which many neighboring dwellings were ignited.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

DECEMBER 7.

942,046. PROCESS OF GENERATING AND STORING OZONE. Frank M. Ashley, New York, N. Y.
942,065. PNEUMATIC-OPERATED SHAFT. Paul J. Grebel, Chicago, Ill.
942,066. FEED FOR PNEUMATIC TOOLS. Martin Hardsocg, Ottumwa, Iowa.
942,100. DRY VALVE. Fred A. Phelps, Laconia, N. H.
942,163. PNEUMATIC POWER-HAMMER. August Berner, Munich, Germany.
942,261. PISTON FOR HOT-AIR ENGINES. Frank B. Hubbard, Middlefield, Ohio.
942,368. AUTOMATIC AIR-TRAP. Richard N. Dyer, East Orange, N. J.
942,441. FLUID-PRESSURE ENGINE. Cyrus P. Ebersole, Keokuk, Iowa.



Pneumatic Patents December 7.

942,598. DUMP-CAR. Harry E. Thompson, Knoxville, Tenn.
942,712. HUMIDIFIER. Frank B. Comins, Sharon, Mass.
942,755. CONTROLLING DEVICE FOR FILLING VESSELS. Gustav Schollmeyer, Kothen, Germany.

DECEMBER 14.

942,887. COMBINATION FLUID AND VACUUM CHECK. Harry T. Case, Franklin, Pa.
942,891. WET SEPARATOR FOR DUST-REMOVING APPARATUS. Ralph F. Diserens, Bradford, Pa.
942,915. PNEUMATIC MUSICAL INSTRUMENT. Paul B. Klugh, Chicago, Ill.
942,935. APPARATUS FOR DISPOSING OF NOXIOUS GASES. William H. Sartain, Columbus, Ohio.
943,022. HYDROGEN - GAS GENERATOR. George F. Jaubert, Paris, France.
943,023. PNEUMATIC PACKING. Edwin S. Johnson, Oakland, Cal.
943,040. AMMONIA REFRIGERATING APPARATUS. Thomas C. McKee, Chicago, Ill.
943,043. BLOWPIPE. Eugene Odam, Paris, France.
943,120. AERIAL NAVIGATION. James Means, Boston, Mass.
943,180. INHALING APPARATUS. Peterson H. Cherry, Los Angeles, Cal.
943,329. PNEUMATIC-DESPATCH-TUBE SYSTEM. Franklin H. Wolever, Chicago, Ill.
943,385. PROCESS AND APPARATUS FOR BURNING OXYGEN WITH OTHER GASES. Arthur R. Bullock, Cleveland, Ohio.

1. The process of burning oxygen and gas which consists in mingling oxygen under pressure with gas in a mixer, supplying oxygen at substantially atmospheric pressure to the mixture beyond the mixer, and igniting said mixture.

943,422. APPARATUS FOR TREATING GASES AND SEPARATING SMOKE AND DUST THEREFROM. Ernest G. Knoepfel, San Francisco, Cal.
943,424. VACUUM CLEANING APPARATUS. John F. Lacock, Boston, Mass.
943,426. SUCTION APPARATUS. Max Lebenberg, Berlin, Germany.
943,556. VACUUM-PUMP. Tom W. Lowden, London, England.
943,583. VACUUM-CLEANER. John N. Whitehouse, New York, N. Y.
943,602. AUTOMATIC AIR-BRAKE RETAINING AND RELEASE VALVE. Daniel F. Knerr, Newark, Ohio.

DECEMBER 21.

943,661. PRODUCTION OF OXIDS OF NITROGEN FROM THE AIR. Francis I. du Pont, Wilmington, Del.
943,732. AIR-SHIP. Amiel Bratschie, New Castle, Pa.
943,833. AIR-HEATER FOR AUTOMOBILE TORPEDOES. Frank M. Leavitt, New York, N. Y.
943,848. VACUUM-PUMP. Frank A. Simonds, Grand Rapids, Mich.
943,901. WIND-MOTOR. Hiram W. Smith, Woolsey, Okla.
943,927. BURNER. Joseph Gehring and Richard D. Conrad, Pittsburg, Pa.

1. In a burner, the combination of a gas reservoir having a wall forming an air tube, and a mixer tube provided with tapering spiral ribs forming tapering channels in communication with said gas reservoir.

943,962. ANEMOMETER. Carl M. Bernegau, Hoboken, N. J.
943,983. TRIPLE VALVE FOR AIR-BRAKES. William B. Mann, Baltimore, Md.
944,024. AIR-VALVE. Hugh A. Fitzpatrick, Chicago, Ill.
944,029. COAL-MINING MACHINE. Arthur H. Gibson, Easton, Pa.

944,034. PNEUMATIC ACTUATING UNIT. Axel G. Gulbransen, Chicago, Ill.

944,064. FLUID-PRESSURE ENGINE. Joel W. West, Omaha, Nebr.

944,148. WIND-MOTOR. Roberto F. E. Okrassa, Antigua, Guatemala.

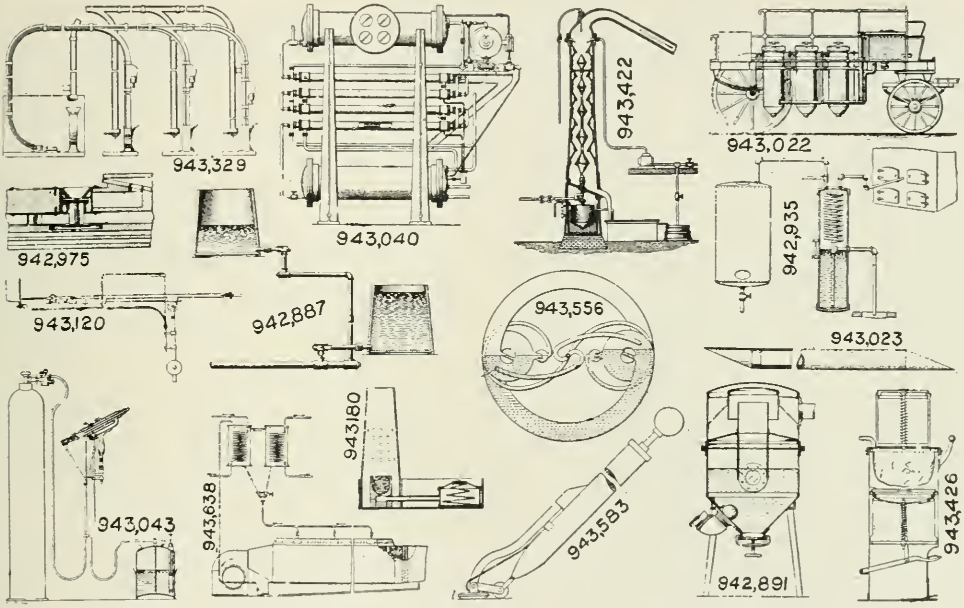
944,151. BRAKE MECHANISM. Emil Santsche, Eureka, Cal.

944,188. AIR-GUN. William A. Heilprin, Philadelphia, Pa.

944,209. BOAT. William J. Reed, Janesville, Wis.

A boat comprising two tubes spaced apart and filled with compressed air, the ends of the tubes pointed, a keel secured to the underside of each tube and tapered to the pointed ends thereof, a deck secured to the upper sides of the tubes and clearing the plane of said upper sides, a propeller located midway between the tubes at the stern, and a rudder secured midway betewen the tubes near the head end of the boat.

944,213. TIRE-PUMP ATTACHMENT. Harry H. Rung, Philadelphia, Pa.



Pneumatic Patents December 14.

DECEMBER 28.

944,255. PRESSURE-REGULATOR. Clarence H. Bong, Chicago, Ill.

944,274. AUTOMATIC GAS-ANALYZING APPARATUS. Ernest H. Peabody, New York, N. Y.

944,278. APPARATUS FOR FILLING RUBBER TIRES WITH VISCOUS LIQUIDS. Albert D. Ray, Cleveland, Ohio.

3. An apparatus for filling rubber tires, comprising a jacketed charging vessel, an air compression tank and inlet pipe communicating with the upper portion of said vessel, a valved outlet pipe leading from the lower portion of said vessel and terminating in a plurality of tire filling nipples, a plurality of oppositely-disposed oppositely-rotating stirring-blades mounted in said vessel, means for rotating said stirring-blades, an auxiliary charging vessel adapted to be brought into communication with said air inlet pipe independently of said main charging vessel and provided with a valved discharge-pipe terminating in a discharge stem disposed at the longitudinal center of said outlet pipe and extending in the direction of the flow of material therein.

944,301. FLYING-MACHINE. Aaron W. H. Warshavsky, New York, N. Y.

944,469. PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles F. Stoddard, Boston, Mass.

944,473. APPARATUS FOR MAKING OXYGEN. George von Ach, Newark, N. J.

944,485. FLUID-PRESSURE BRAKE SYSTEM. James A. Hicks, Atlanta, Ga.

944,487. PNEUMATIC-DESPATCH-TUBE APPARATUS. Chester S. Jennings, Brookline, Mass.

944,577. HYDROPNEUMATIC SPRING. Henri Oudinot and Charles Putois, Coudray Montceaux, France.

1. A hydropneumatic spring comprising in combination a cylinder filled with suitable liquid, an air chamber filled with air under pressure inclosed in said cylinder, a piston adapted to penetrate into said cylinder, suitable means for guiding said piston in the bottom of the cylinder, an india-rubber bag co-operating with the head part of said piston, means for guiding said india-rubber bag upon said piston, and means for obtaining a perfect joint between the india-rubber bag, the piston and the cylinder substantially as described and for the purpose set forth.

944,672. CHANNELING-MACHINE. Arthur H. Gibson, Easton, Pa.

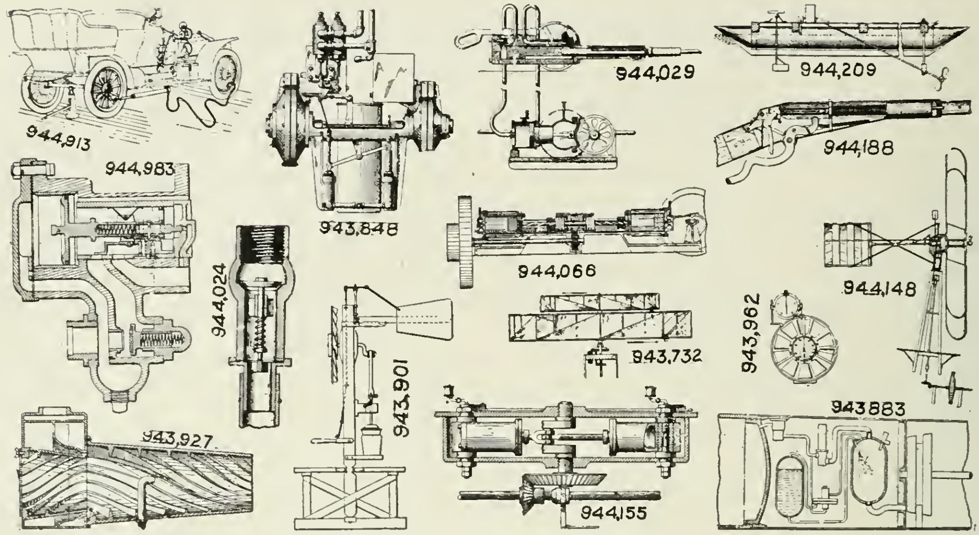
944,717. AGITATING DEVICE FOR MIXING CARBONIC-ACID GAS AND WATER. Louis Caul, Cleveland, Ohio.

944,737. VACUUM MASSAGE-MACHINE. Nathaniel Lombard, Akron, Ohio.

944,750. ROCK-DRILL. William C. Stephens, Cornwall, England.

944,779. MEANS FOR OBSERVING AND SEPARATING HEAVY OBJECTS FROM DUST-LADEN AIR-CURRENTS. Daniel Fogarty, Ottawa, Ontario, Canada.

944,798. PNEUMATIC RELAY FOR AUTOMATIC MUSICAL INSTRUMENTS. Arthur W. Lonsdale, Bedford, England.

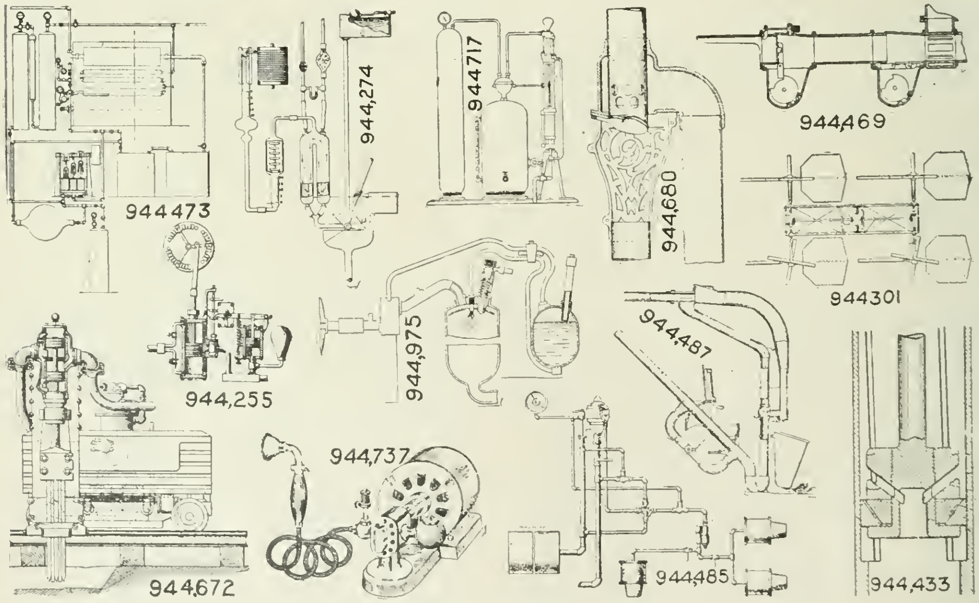


Pneumatic Patents December 21.

944,912. ROTARY AIR AND GAS PUMP. Lebbeus H. Rogers, New York, N. Y.

944,975. HEATING OF COMPRESSED AIR FOR USE IN MOTORS. William H. Sodeau, Newcastle-upon-Tyne, England.

1. A device for heating compressed air by burning in it a fuel, comprising in combination, a combustion chamber, inlet means for air into said combustion chamber, a deflector situated over the air inlet means and interposed between the fuel inlet means and the air inlet means whereby the main volume of the incoming air is deflected away from the fuel inlet means, said deflector having openings of small area whereby a relatively small quantity of air is passed to support combustion of the fuel issuing from the fuel inlet means.



Pneumatic Patents December 28.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV MARCH, 1910 No. 3

COMPRESSED AIR FOR VENTILATION AND SAFETY IN MINES

At the Spokane meeting of the American Institute of Mining Engineers, in the discussion of the excellent paper by Mr. D. W. Brunton, on "Modern Progress in Mining and Metallurgy in the Western United States," Mr. W. L. Saunders spoke upon mine ventilation, saying, in part:

The importance of this subject can scarcely be over-estimated. It should surely be the province of the mining engineer not only to excavate material and treat it properly and economically, but in doing this he should study how to protect and conserve the lives of the miners. John Mitchell's figures show that four times as many men are killed in mines in the United States, in proportion to the number of men employed, as in any other country in the world. Explosions are responsible for much of this, but where explosions occur human life may be saved, provided there is a complete system of ventilation in the mine, and provided certain safeguards are employed. For instance, it has been urged by Mr. Mitchell that the introduction of compressed-air pipe-lines into all the workings of a mine might provide fresh air and even food to men imprisoned after explosions or through falls. This does not involve much expense, as mines are usually equipped with compressed-air apparatus, and the piping leading into the mine is of such a nature as to withstand considerable damage from the exterior. Furthermore, this piping at certain places, as, for instance, in the shaft, might be still further protected. Telephone wires inserted within the air-pipe might also serve a useful purpose in saving life.

Under Section VI., Underground Tramming, Mr. Brunton refers to the air and electric locomotives which have come into general use, and he makes the statement, which no one can dispute, that each has its own field. Following this, however, the claim is made that "where the openings are dry and the roof sufficiently high and firm to carry the trolley-wire insulators, there is no question as to the desirability of using electricity." This seems to be a rather slender hook on which to hang the interests of the compressed-air locomotive. The members of this Institute recently visited the Anaconda smelters where we saw air-locomotives doing useful service throughout the works. The superintendent when asked why he used air in preference to electricity answered, because it was better and cheaper. This is only one notable instance where air is preferred for traction purposes. There are many others, as, for instance, the Homestake, the largest and richest single gold-mine in the world, where air-locomotives do useful service not only in the yards but in the mines themselves. These installations, Anaconda and Homestake, are of the old type; that is, the simple compressed-air locomotive. Notwithstanding this, the results are satisfactory and economical. There is a new type of locomotive, built by the H. K. Porter Co., of Pittsburg, which should be able to add 50 per cent. to the saving in air-economy. This new type uses the natural heat of the mine as a reheater to expand the air between the high and the low pressure cylinders. Under the old system of simple compressed-air locomotive it was frequently true that the fuel required to furnish the power for the air and the electric systems was almost exactly the same. With the new system it is claimed that under the same conditions the fuel-requirements in air will be but two-thirds of that made necessary in an electrical installation. There are some conditions where the electrical installation might prove more economical even than the compound compressed-air locomotive. Much depends upon the load-factor. With a good load-factor of from 30 to 40 per cent. of the rated power of the engines and generators furnishing the current, and with mining conditions which permit operating locomotives at rated speed and power, it should be possible with electric locomotives to obtain efficiencies approximating those found in connection with the operation of large street-railways; but in ordinary mining conditions there is much starting and stopping, tracks are crooked and curves frequent, and the ordinarily very poor load-factor results in an efficiency in mines even below that of the simple compressed-air locomotive.

Trolley-wires in mines are always more or less a source of danger, annoyance, and expense. This is especially true in gold, silver, and copper-mines, where many of the levels are operated simultaneously, and where the output per level is comparatively small. In such cases it frequently requires the services of several men and large quantities of copper-wire and insulators to keep the haulage-locomotives in close touch with the various working-places. Even in cases where the openings are dry and the roof high and firm, the trolley-wire becomes a menace when there is a wreck on the road or any other accident resulting in a short circuit.

Wherever the wires are carried near ore-chutes, or places which require occasional or frequent blasting, they are in danger of being ruptured or put out of service. Furthermore, the danger from the fire cannot be over-estimated, inflammable material being frequently in proximity to the wires.

The long entry to the mine can obviously best be equipped electrically, but in the various ramifications of the mine compressed air has been proved to be safest and best.

The argument that the air-locomotive loses time in charging has some merit, but observation of the performance of the electric locomotive in mines proves that the time lost in handling the trolley-pole under ordinary mining-conditions is approximately as great as that due to charging the air-locomotive. In narrow drifts it is sometimes found impossible to turn the trolley-pole, and the locomotive has to be run a considerable distance with the trolley-pole in advance of, instead of trailing behind, the support. Under such conditions very slow speed and great caution are required in order not to break the poles or tear down the wiring. Ordinarily charging a compressed-air locomotive means the loss of about a minute and a half for every 4,000 ft. of travel.

ROCK DRILLS.

It is to be regretted that Mr. Brunton dwelt so briefly upon the subject "Rock-Drills," for surely this valuable adjunct to the miner deserves serious consideration. The rock-drill has made the mining and smelting of low-grade ores profitable. Development-work, tunnel-construction, drifting and stoping are all pursued to-day to a greater extent than in olden times, because the rock-drill has been perfected to that stage of simplicity where it may be used profitably and economically. It is difficult to find in the list of mechanical appliances a machine which has been subject to greater wear and tear or in the building of which experience is of more importance, than the rock-drill. The design of a rock-drill is not by any means everything to be considered in looking for the best. Material and workmanship are of the greatest importance, and the skill which can only come of experience when applied in the construction of this important mining-tool should surely be of value to the miner who is seeking a reliable machine for permanent use.

AN UNUSUAL TUNNEL EXPLOSION

The work of constructing the new aqueduct for the Catskill water supply for New York City is being pushed rapidly, the various contracts employing in the aggregate a great number of men, and it has hitherto been highly gratifying to note the infrequency of serious accidents as the work has progressed, but an explosion which occurred in the heading of the McKeel tunnel near Cold Spring on January 21, helps to make up the fatal average. This explosion, it would seem, must remain unexplained. The report of the engineers of the Board of Water Supply gives all the facts with clearness and frankness, but leaves much to individual opinion as to the details of the occurrence.

It is explained that the usual practice included a heading round of 22 holes; 6 for the center cut, these being from 8 to 9 feet deep and the others 7½ to 8 feet. The rock was so tough and hard to break that it was necessary to fire the cut several times before blasting the side rounds, the firing being done by battery outside the tunnel. There were only 15 men in the tunnel and 10 were killed, including the foreman. The five who were saved were some distance back from the heading, and got to the outside without assistance, but were so seriously affected by the concussion and the gas that they could give no coherent account of the occurrence.

At 2.30 p. m. the first shot on the 6 center cut holes of the heading were fired, at 2.50 p. m. the second shot was fired and some 10 minutes later the men re-entered to load for the third shot. At 3 p. m. a much heavier explosion than usual attracted the attention of the men outside, and soon afterward the survivors were seen crawling from the entrance. Attempt was made to enter the tunnel to rescue the other men, but the gases and smoke prevented any such rescue work for a full hour. When finally the heading could be reached, eight of the bodies were found on the main bench just over the heading bench and two bodies, including that of the foreman, on the heading bench near the cut. None of the bodies were greatly mutilated, as they would have been by a heavy fall of rock, and death had been caused by concussion, not by asphyxiation.

There were no indications of an extensive explosion. The four upper holes of the six holes for the center cut were loaded preparatory to the third blast, but investigation failed to show that the lower two of these six holes had been loaded, although they were covered with the muck from the explosion.

Two explanations have been offered: The first is that the rock had become so heated from the two successive blasts as to have set off the powder as it was being loaded for the third blast. This is discredited. In the first place the dead foreman was known as a most careful man who certainly would have determined the heat of the holes before loading them. Then, the four upper holes of the cut still contain the load for the prospective third shot; had the explosion been in the heading these shots must certainly have been burned, thrown out or exploded. Finally, after each regular blast it was possible to clear the tunnel in 10 or 15 minutes, but the fatal explosion so fouled the air that it was an hour before entrance could be had. This would indicate that the explosion took place in the open bore and not from heating or by the accidental discharge of a previous misfire.

The other explanation is that the dynamite resting on the bench for use in loading the holes, probably a 50-lb. box, and perhaps more, was exploded by some shock, such as the falling of a small stone on a cartridge with exploder attached. This theory is borne out by the condition of the heading, which is not shattered as it would have been by an explosion in the holes, by the location and condition of the bodies and the evidence, noted above, that the explosion was in the open.

CATS IN FORMALDEHYDE

At the coal mines of the Northwestern Improvement Company at Red Lodge, Montana, the Drager rescue apparatus has been tested with satisfactory results, and is now being permanently installed. One of the tests is thus reported:

There was a two-hour test of endurance at the test house at the mine today and the men came out of a room that had been charged with formaldehyde in good spirits and as fresh as if they had been travelling over the bench land in the invigorating air of this community. They experienced no inconvenience whatever, except the heat of the hermetically sealed room. Their breathing was as natural as if they had been walking on the soil, and after going into the fresh air they did not have any unusual feeling in or about their natural breathing apparatus.

On a couple of the tests cats were taken into the room. The first, upon entering, jumped up into the cage and scratched as if trying to get out. Then it sniffed and sneezed and scratched its nose with its paw, then it executed a few devilish whirls and settled down peacefully to die, while froth covered its mouth and its eyes grew dim. When it was about to bid farewell to its tormentors it was taken outside, where, in due time, it recovered. The next cat showed signs of wanting to die very soon after it had been introduced to the formaldehyde.

A NEW HYDRAULIC ROCK DRILL

A new hydraulic rock drill has made its appearance, the invention of Mr. Warlaw Wolski, an Austrian engineer, and one of the best known figures in the petroleum industry of Galicia. As the practical success of the drill cannot as yet be considered as demonstrated it is of interest to our readers chiefly as a proposed competitor of the air driven drill. A study of the drill in detail shows that after all it is by no means independent of the air. The following description we take, with some condensation and omission, from *The Engineer*, London.

Certain very real disadvantages have militated against the adoption of hydraulic power for rock drills up to the present time. The difficulty of constructing a powerful hydraulic motor lies in the nature of the force-transmitting medium, which is heavy and almost incompressible. Every stoppage and every change in direction of the motion of the water is necessarily accompanied by a more or less heavy shock of the water in the pipes and the motor, and this phenomenon, increasing in force with the rapidity of the motion, limits the speed of working in a very definite manner. It being impossible to overcome the difficulty of the hydraulic shock, Mr. Wolski has utilized it, and, in fact, in forms the basis of the action of his apparatus.

Reference to the diagrammatic sketch of the apparatus given in Fig. 1 will render the mode of action clear. The drill consists essentially of a cylinder, in which is a piston C free to move, while at the other end of the cylinder is a flap valve D, which is kept open by a spring. The interior of the cylinder is in communication with a "striking tube" F G, at the end F of which is an air vessel. When the valve H is opened, water flows through the apparatus, out past the valve D, into the waste pipe E. The rush of water past the valves causes the pressure on the under side to be less than the pressure on the upper side, where the velocity is less. This, of course, is in accordance with the well-known law of hydraulics, the pressure being least where the velocity is greatest. The two are, in fact, connected by the relation—

$$\frac{v^2}{2g} + \frac{P}{w} = \text{constant},$$

v being the velocity of the water in feet per second, P the pressure in pounds per square foot, g the acceleration of gravity, w the weight of a cubic foot of water.

In the present instance differences of level can be neglected. When the velocity attains a certain value the difference of pressure is sufficient to close the valve, and the column of water in the striking tube is suddenly stopped. The kinetic energy of the water in the tube is communicated to the piston C, which is impelled forward with high velocity, and the drill which is at the end of it strikes a heavy blow on the stone or rock being bored.

The pressure in the interior of the cylinder is diminished by the moving out of the piston C, and at the same time the water, having been compressed by the shock, acts like a spring, and surges back into the air vessel. The extent of the surging is of course very small, on account of the small compressibility of water—about 48-millionths of its volume for each atmosphere—but the combined effect of these two is to cause the pressure in the cylinder to fall low enough for the valve to open. Water then streams through the open valve. The piston is meanwhile being brought back to its original position by springs, but before it is right back, and while it still has an appreciable velocity to the left, the valve D closes, and the direction of motion is reversed by the hydraulic shock. The drill then strikes another blow as before. The actual apparatus is shown in section and plan in Fig. 2, which is roughly to scale. the overall length being about 4 ft.

It will be noticed that the boring bar is rifled. The female part of the rifling arrangement is provided with a spring device, whereby the rifling is only engaged on the return stroke. The drill thus strikes a direct blow with a rotary return. The boring bar passes at its right hand end through a guide which is packed with a leather packing. It is easily replaced when worn. The whole drill can be dismantled in five minutes for inspection. The drill is bolted to a drill post, which may be either held between roof and floor in the ordinary way, or supported on a carriage, or, for small power drills working soft rock, may be supported on a tripod.

The actual magnitude of the blow depends primarily upon (1) the weight of the striking column; (2) the velocity of the water when the valve closes; and (3) the weight of the chisel and boring bar.

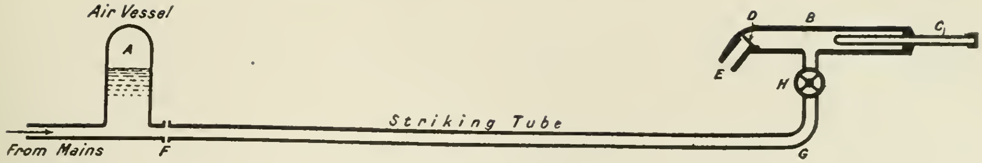


Fig. 1

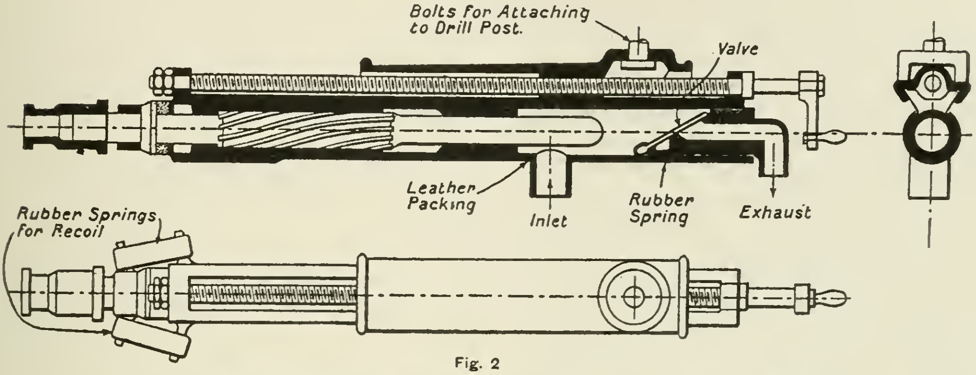


Fig. 2

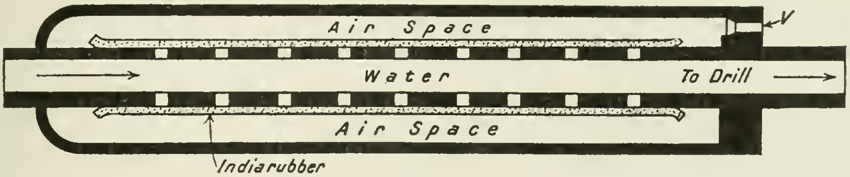


Fig. 3

A NEW HYDRAULIC ROCK DRILL.

Since the kinetic energy of the striking column is

$$\frac{1}{2} \times \frac{w}{g} v^2 \text{ foot-pounds}$$

where w is the weight of the column, v the velocity at the instant the valve closes, in feet per second, $g = 32$ ft. per second, it follows that the magnitude of the blow will be proportional to the weight of the striking column and to the square of the velocity of the column. The weight of the chisel and boring bar affects the problem in so far that a certain relation between the weight of the striking column and that of the chisel and boring bar, is necessary in order to ensure the most efficient transmission of the energy of the striking column to the chisel and boring bar. As a matter of fact the best effect is obtained when the mass of the striking column is equal to the combined mass of the chisel and boring bar.

The velocity of the column is fixed by the velocity at the valve required to produce the necessary difference of pressure to close the valve, *i. e.*, it is fixed by the stiffness of the spring controlling the valve. The rapidity of the blows is limited by the fact that after each blow the striking column is brought to rest, and it must be accelerated up to the requisite velocity before the valve will close. The rapidity of working depends, therefore, upon the pressure which is urging the column forward, *i. e.*, it depends on the pressure in the supply mains. The actual magnitude of the blow is said to be unaffected by the varying pressure in the mains, and to depend only on the weight of the striking column and the strength of the spring controlling the valve. The inventor claims that machines of the type described strike from 20 to 30 blows per second, while the maximum speed of percussion machines of existing types is from 3 to 5 strokes per second.

One of the Wolski machines has recently undergone a series of tests at the Millbank Pumping Station of the London Hydraulic Power Company. The pressure used was 450 lbs. per square inch. This, with a particular type used, would give a pressure in the interior of the apparatus of 3000 lb. per square inch. The tests were carried out on a block of hard Portland stone. The diameter of the drill used was 2 3-8 in., and on an average progress was made in the stone at the rate of 10½-in. per minute. This is equivalent to the removal of 46 cubic inches of stone per minute. The drills stood up to the work so well that after holes aggregating about 25 ft. in depth had been drilled, it was not necessary to do anything to the edge. A stream of water plays on the chisel the whole time, and serves the three-fold purpose of keeping the chisel cool, of rinsing the bore-hole, and of allaying the dust.

The machines can, we understand, be made to work at any pressure from 5 atmospheres (75 lb. per square inch) upwards. For the softer rocks, such as coal, the lower pressures may be used with advantage, but for the harder rocks where a larger striking tube and heavier drill bits are used, the higher pressures are recommended, the increase of effect with the higher pressures being very marked. If the striking tube is arranged to be straight and nearly to coincide in direction with that of motion of the chisel, there is, it is explained, very little shock on the machine, since the force of the shock is transmitted directly to the chisel, and the machine merely serves as a casing and guide for both masses. There is, however, no absolute necessity for the striking tube to be straight, if the conditions do not admit of it easily.

The consumption of water for all purposes in a machine of the above type is from 3 to 4 cubic feet per minute. The weight of the apparatus upon which the tests were made is about 100 lb. This is the weight of the machine itself, exclusive of the stretcher bar, striking tube and air vessel. The drill may easily be manipulated by two men, and, if necessary, can be controlled by one. During the tests at Millbank one man only, we are informed, was employed on the drill.

The air vessel used is not the type shown in the general arrangement sketch, which is only diagrammatic, but is of the special and ingenious design shown in Fig. 3. The wall of the inner tube is perforated by a large number of small holes like a sieve. Over this is stretched an india-rubber tube, fastened by tying up at both ends. The whole is covered by a steel tube, closed hermetically at both ends, and the space between this tube and the inner one is filled with air, forced in through the valve V by means of a pump. During the boring work the hydraulic pressure and the air pressure act against one another, and the india-rubber, now expanding, now contracting, forms the elastic separation between the air space and the water space.

POSSIBLE ECONOMIES IN ICE MANUFACTURE

Some twenty-five years ago, when a mere boy, the writer was projected, much against his will, into the ice machine business. A complete stock of general ignorance in this especial line enabled him to stumble through one or two jobs successfully, and as time wore on the beauties of the situation unfolded. Being a chap of ordinary brightness, he absorbed and compressed into his storage tank some very interesting experiences, and was soon thoroughly familiar with the situation as it then was.

Having an inquiring mind, he naturally bored into many abstruse questions, the leading one of which was "Why do we burn coal to make ice, as it seems like a paradox?"

To-day he is still unable to give a logical answer, as his mental excursions into the realms of thermo-dynamics failed to reveal one. Theoretically, we should gain heat instead of losing it. However, we passed it up, and now ask another question or two, viz.: Why are we content to burn 400 lbs. to 500 lbs. of coal to make a ton of ice when it can be very comfortably done on 200 lbs. by steam power, and 100 lbs. if the gas-producer is used with gas engines?

Question No. 2. "Why has the development of the artificial ice machine remained nearly stationary during this long time?" In 1880 the battle raged between the compression and absorption systems and the relative merits of the wet and dry compression. To-day it is still raging on the same points, with practically little advantage on either side and neither doing much better than at first. Some improvements have been made from time to time, but the results remain practically the same. In support of this statement, I call attention to a page advertisement in a recent issue of a trade journal, which advertises that a builder of distilling apparatus has taken a certain modern plant, which was turning out 2.89 tons of ice to the ton of coal, and improved it so that it now makes 3.60 tons to the ton of coal. Good for the apparatus! but isn't this a rather humiliating state of affairs when a ratio of 1 to 10 should be easy of attainment? This is not an isolated case. The majority of small plants do not turn out more than four tons of ice to one of coal, and it is tight work to make the plants pay. Like the rheumatic old gentleman who feels the coming storm before it breaks, does not the operator of the small plant feel something which indicates a disturbance in the atmosphere of the ice business—sort of a heavy humidity which oppresses him? F. A. Rider in *Ice and Cold Storage Journal.*

COMPRESSED AIR BATHS

At the Brampton (London) Hospital for Consumption and Diseases of the Chest a compressed air treatment is in use and, on newspaper report, with gratifying success. A large round air chamber is provided with a compressor for supplying the air. There is a door for entrance, and several port holes closed with plate glass. There is also an air lock for occasional use. There is within a table and three or four chairs, that number of patients being treated at a time. The normal atmospheric pressure is only raised about one-third of an atmosphere, or from 30 to 40 inches of mercury.

When the patients have entered the pressure is augmented so gradually that it takes half an hour before the full pressure is reached, which is manitained for an hour, and then half an hour is taken for the return to the normal. Reading or quiet games pass the time; a sign within reads: "Talking strictly forbidden." The necessity for this is thus explained by Dr. Wood, the physician in charge:

"You see, the effect of the compressed air, apart from its curative action, is rather curious. It has, if anything, a rather exhilarating action, and gives rise to that happy feeling said to be experienced by those who climb high mountains. Now, you can quite see that, in any case, it might be bad for patients, perhaps rather weak, to start a conversation which might possibly develop into a hot argument."

"It is impossible," Dr. Wood continues, "to explain the exact effect of the treatment. It is certainly beneficial in many cases of bronchitis or asthma, but whether that is caused by the increased amount of oxygen in the bath or whether the pressure expands the cells of the lungs or air passages I hardly feel qualified to say. Some time is taken, anyway, before the good effects are felt, and a complete course means some twenty baths, taken at intervals of three times a week."

HIGHER PRESSURES FOR GAS SERVICE

During the past year several gas companies in this country, including those at Boston, Chicago, Milwaukee and Detroit, have experimented with high-pressure gas lighting, with encouraging results, especially when employing burners made for, and properly adapted to, high pressure. In Europe, notable progress has been made in this direction, particularly in Berlin, where, on July 1st of this year, 25 miles of streets were being lighted with 1,531 high pressure gas lamps, supplied by four separate compressors, with gas at from 53 to 78 inches of water pressure, and giving light, in some cases, of over 4,000 candle-power each. It was stated last April that Berlin had decided to spend 7,000,000 marks, at the rate of 1,000,000 marks (about $250,000) per annum, in installing in all thoroughfares incandescent inverted gas burners under pressure; and that this decision had been arrived at after much investigating and experimenting by competent officials. Fleet street, London, and some parts of its adjacent streets, and also some fine bridges in that city, are being very successfully and brilliantly lighted in this way, and further extensions of the system are being made and contemplated. Other cities in Germany outside of Berlin, and others in England outside of London, are also beginning to adopt this system of street lighting. In Fleet street the cost is said to be one penny per hour per 1,500 candle-power of light. In Berlin the consumption for a given quantity of illumination is said to be one-quarter that of the former low-pressure lamps used, and the lighting is said to be very much cheaper than electric lighting, even with the latest type of electric burners.

THE DUST PROBLEM OF THE SAND BLAST

A valuable series of papers by Dilien Underhill is appearing in current issues of The Foundry, and from the latest we abstract the following dealing with important features of sand blast apparatus and its profitable manipulation.

The cleaning of castings for enameled ware is accomplished largely by the use of the sand blast. By this means a perfectly clean casting can be obtained, and no dust, which is injurious to the enamel, is left on the metal. If any of the sand blast is left on the casting it will melt and form a part of the glass, which is a constituent of the enamel. The most serious problem in sand-blasting is the removal of the dust. The air in the room where the sand-blasting takes place is saturated with a fine powder from the broken particles of sand, and if not properly taken care of will penetrate adjoining buildings, rendering them uncomfortable and unhealthful.

EXHAUSTING THE DUST INTO WATER.

Naturally, one would think that exhausting into or under water would solve the problem. This, however, is not the case. When the dust is exhausted into tanks, it forms into little globules, and these rise to the surface, open up, and the dust nuisance is still the same as before. Of course, some dust settles to the bottom; but sufficient rises to the top to make the system ineffective. In one instance, the dust was exhausted into a river and it was believed that the volume of water would be large enough to moisten the particles, but this proved as unsatisfactory as the water tank, and it was soon abandoned.

THE DRY EXHAUST SYSTEM.

Two general systems of dust elmination have been developed, both of which have proved successful. The dry system of exhausting through cloth is being installed by a prominent manufacturer, in many enameled iron plants. Briefly, an exhaust fan carries the dust and air into an enlarged chamber where its velocity is spent in attaining a larger volume. The dust strikes the cloth but does not pass through it, while the air seeps out with hardly any perceptible current. The sand drops down into a receptacle and is removed.

THE STEAM EXHAUST SYSTEM.

The second system, while probably not quite as clean as the dry method, has the advantage of being inexpensive both in installation and maintenance, as it can be built by a carpenter and a plumber in a short time. It takes care of all the dust by exhausting steam into a large wooden chamber into which the sand blast dust also is exhausted. At A, Figs. 1, 2, and 3, is shown such an arrangement. For the two sand blast rooms, a tower, built of rough boards, set on end, is provided. It is about 20 feet high, 5 feet in diameter at the bottom and 3 feet at the top. Exhaust steam discharges into the top of the tower. The dust from the sand blast rooms enters lower down and has a tendency to rise. The steam condenses, mixes with the sand, and both are precipitated. If the door is left open, the wet sand will fall out to be carted away or, it can be carried out on a belt conveyor.

THE SAND BLAST ROOM.

The sand blast room is usually about 10 feet square and 10 feet high. The walls should be lined for a short distance with metal to resist the wear of the striking sand. Fresh air should enter from the roof or along the sides near the roof, from several openings, to prevent a draft on the workman. The exhaust should be from the bottom, as shown, to accommodate two rooms. With this arrangement, the workman has an ample supply of fresh air and this minimizes, as much as possible, the rising of the fine dust. In any case, a helmet and gloves must be worn to protect the skin from the sand. This method does away with an aspirator if the proper exhaust fan is used, and the room is occasionally allowed to clear itself of dust entirely. In some plants, two men work in each room. They alternately relieve each other in carrying the castings to and from the room and sand-blasting them.

In exhausting the sand, baffles are introduced to deflect the larger particles into the pit. Only the finest dust then goes up into the fan. The coarser grains flow into the pit and are carried up in an elevator to a storage tank or box to be used over again, as shown in Fig. 3. This sand can also be taken care of in a hopper underneath the floor as indicated by the lines XX, Fig. 2.

In this case a grating would be used and no sand would have to be shoveled. It is not desirable to pass the sand so direct as this to the sand blast machine, as a rotary riddle should be installed under the elevator spout to take out scrap, gates, and runners, which would otherwise clog the machine. A very small particle will close the slot in the sand blast machine.

slightly inside the sand blast room. The sand can then be shoveled into the top of the machine through an ordinary sieve. With the system shown, a rotary riddle should be placed under the elevator spout. The sand blast installations of a number of sanitary ware foundries are similar to that shown in Fig. 4.

It is quite simple in operation. The sand is placed in the upper sand hopper, the air is cut off and the sand inlet valve drops down as shown in Fig. 4. The sand then falls through the inlet *E* and drops down into the lower sand bin. When this is full the inlet valve is raised against its seat by pulling up the ball handle. This is held in position until the compressed air is let into the tank, and when the full pressure of air is on, it is held firmly in place. The air then passes out through the ejector and into the hose. The hand wheel is next given a few turns and this pulls out the sand gate, allow-

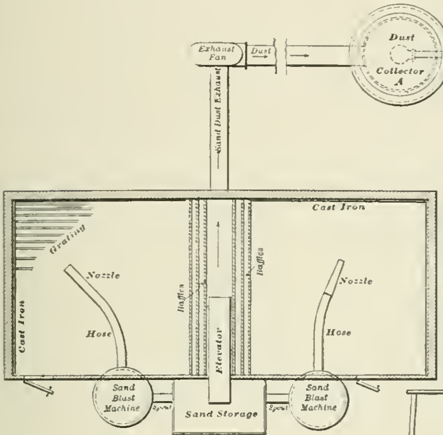


FIG. 1

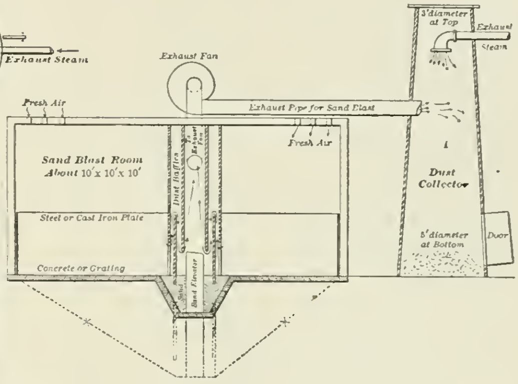


FIG. 2

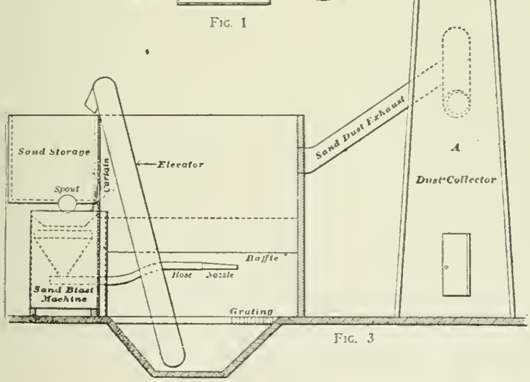


FIG. 3

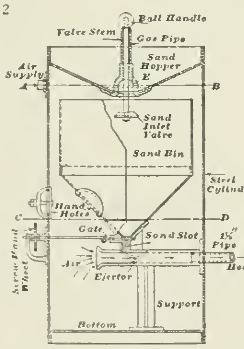


FIG. 4

SAND BLAST ARRANGEMENTS.

New sand must be thoroughly dried before it is placed in the machine hopper. The description in detail in the article quoted of arrangements for sand drying it is not necessary to reproduce here.

THE SAND BLAST MACHINES.

The sand blast machine is shown in Fig. 1. When the grating is not used, it is convenient to have the edge of the cylinder set ing the sand to fall down into the ejector. The sand and air are proportioned by the hand wheel and a lever is sometimes used instead of the wheel, with a set screw as a gage for the sand gate opening. The current of air, under 20 to 30 pounds pressure, carries the falling sand along in a continuous stream and projects it against the casting. The air flows out with a steady pressure, assuming that the supply is kept up, and the outside cylinder, being closed top and bottom, serves as an air reservoir. The machine is built of 3-16 inch steel plates, and the cylinder is 30 inches in diameter and 4 feet 6 inches high for this capacity.

The sand hopper is usually a casting, or a plate and a casting as shown, the latter being preferred as it is more easily machined. The sand bin rests on top of the conical projection of the ejector and is riveted or bolted to it. This is its only support. It is set away from the outside shell 1½ or 2 inches. Hand holes are provided in the shell and also in the sand bin so that the slot, which chokes up if the sand is not dried and screened properly, can easily be cleaned.

The sand bin man-hole is an ordinary curved plate, held in position by the air pressure. The shell manhole must be held in place with a gasket and bolt as shown, or the air will leak out. Air leakage is expensive and difficult to detect, and for that reason all joints should be carefully tested.

Man-holes are frequently provided in the upper sand hopper as well as in the bottom, to facilitate cleaning out. Sand blasts are often built without the support shown. If it is not cast integral with the ejector, it should be braced separately instead of hung from the side alone.

The Soo Canal opened to commerce a little over 100,000 tons in 1855 with a depth of 11½ ft. on its mitre-sills, when there was a scant 8 ft. of water on the St. Clair flats. Successive enlargements of the locks and deepening of the restricted Lake channels now give an available depth of about 20 ft. In 1907, 58,217,214 tons of freight were carried through the locks of the Soo. The freight was slightly over 20 per cent. of our railroad ton-mileage. The cost of service fell from 1.5 mills in 1888 to 0.69 in 1908, 9 per cent. of railroad rates.

AIR COMPRESSOR CYLINDER RATIOS

The following we condense from a paper by Mr. Snowden B. Redfield in a recent issue of the *American Machinist.*

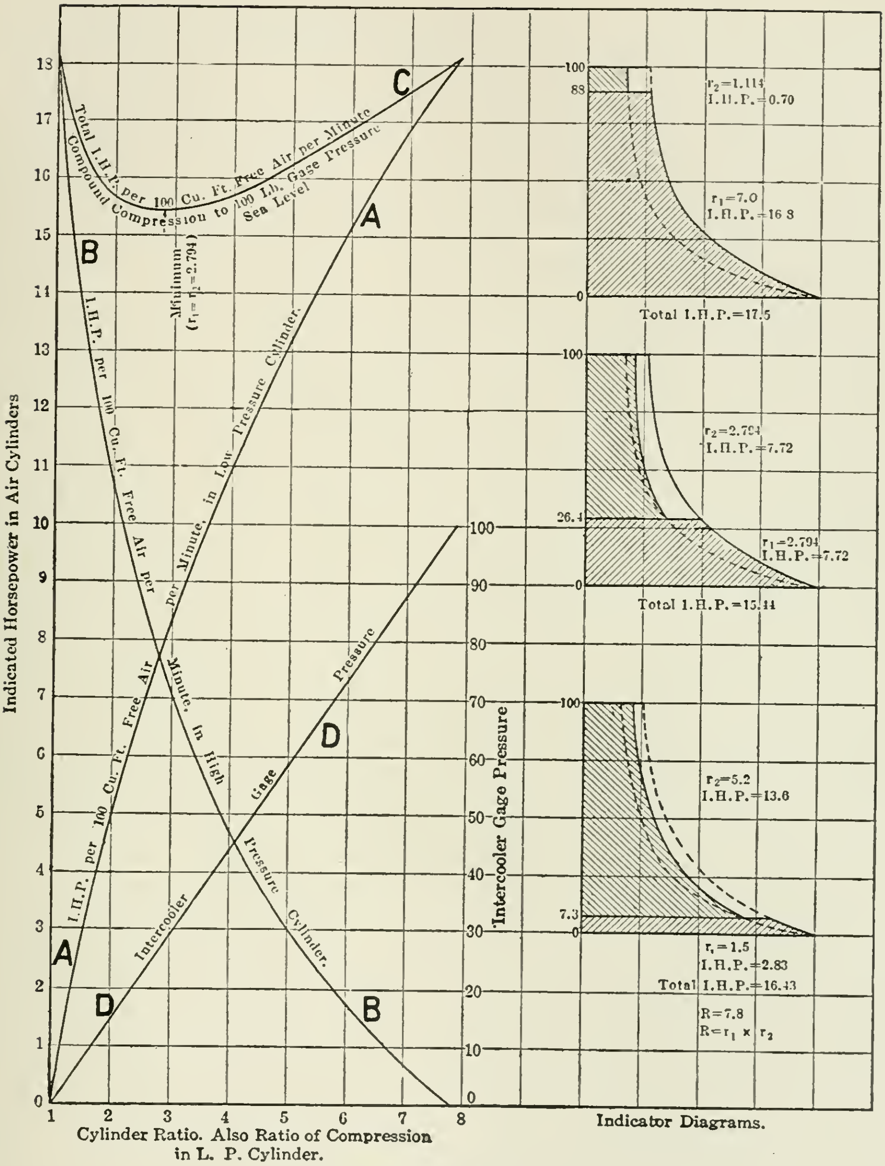
Power saving by stage compression in an air compressor is due solely to the cooling of the air between the stages, and without the intercooling the work could be done slightly more cheaply in the single cylinder.

On the right of the accompanying cut are three theoretical indicator diagrams of a compound air compressor working from atmosphere to 100 pounds gage with different cylinder ratios, the actual compression being assumed to be adiabatic in each case. In the middle diagram the assumed cylinder ratio is 2.792, the square root of the total compression ratio, which is 114.7÷14.7=7.8. With the ratios here assumed the work of the two cylinders is equal, and the total power required for the compression will be the minimum.

In this diagram compression in the first cylinder is carried up along the adiabatic line from atmosphere pressure to that of the intercooler, which is 26.3, gage. This is obtained by multiplying the atmospheric pressure, 14.7 pounds absolute by the cylinder ratio and subtracting 14.7, like this: 14.7×2.792=41.04 and 41.04—14.7=26.3. All the air entering the low pressure cylinder must go into the high pressure cylinder after cooling to the original temperature, and at equal temperatures the absolute pressures are inversely proportional to the volumes. This reduction in the volume of the air by the intercooling is where the saving of power occurs in compound compression.

Compression in the high-pressure cylinder follows up the adiabatic line as shown, until it eventually meets the 100-pounds pressure line, when the air is discharged from the cylinder. The shaded area below the 26.4 pounds pressure line represents the work done in the low-pressure cylinder, and the shaded area above this line represents the work done in the high pressure cylinder. Under the imposed conditions these two areas will be equal. That portion of the diagram which is unshaded represents the amount of work which is saved by compounding over and above what would have to be done if the compression were in a single stage.

In the diagram below the one we have been considering the cylinder ratio is made 1½, or



AIR COMPRESSOR CYLINDER RATIOS.

the low pressure cylinder has only 1½ times the volume of the high pressure cylinder and the intercooler pressure is only 7.3 pounds gage. The temperature of the air as it leaves the low pressure cylinder is not as high as in the previous case and consequently there is less reduction of temperature and volume in passing through the intercooler, and less possible saving of power as the result of the intercooling.

In the upper indicator diagram an extreme of ratio in the other direction is noted, the cylinder ratio here being 7 to 1 and the intercooler pressure 88 pounds gage. The shaded area above this pressure line represents the work done in the high pressure cylinder, which is very small compared with that done in the low pressure cylinder.

As shown by these three diagrams, the horse power in each of the two cylinders varies with the cylinder ratio and the total horse power, or the sum of two, varies also. At the left side of the cut before us are given several curves having to do with the entire range of cylinder ratios, and consequent ratios of compression, from 1 to 7.8, the units of these ratios reading on the lower horizontal line. The curves *A* and *B* show the horsepower of the low pressure and of the high pressure cylinders respectively. Starting at the left on line *A* the horse power in the low pressure cylinder increases from 0 with a cylinder ratio of unity to a maximum of 18.1 with a cylinder ratio of 7.8, the latter being the highest possible ratio when compressing to 100 pounds. With a cylinder ratio of unity, or with both cylinders of the same capacity, all the work of compression would be done in the second or high pressure cylinder, this amounting to 18.1 and dropping off, according to the curve until with a cylinder ratio of 7.8 it finally reaches 0.

Rerferring now the upper curve, *C*, "total indicated horse power per hundred cubic feet of free air per minute," etc., it will be found that the minimum total horse power occurs, for 100 pounds final pressure, when the cylinder ratio is 2.794, the ratio of compression in both cylinders being the same, the actual horse power also being the same in both cylinders 7.72 and the total horse power of course 15.44 per hundred cubic feet per minute compressed to 100 pounds gage.

For three stage compression the cylinder ratios would be the cube root of the total ratio of compression, and for four stages the ratios of the contiguous cylinders would be the fourth root of the total ratio.

In ordinary working perfect intercooling is never obtained, the effect of which is to slightly raise the intercooler pressure and the intake pressure of the high pressure cylinder above that of theoretical conditions. This of course throws back more work upon the low pressure cylinder, and to obviate this it is considered good practice to make the actual cylinder ratio a little less than the theoretical ratio.

The clocks of Paris, operated by the Popp pneumatic system, were stopped for three weeks by the flood.

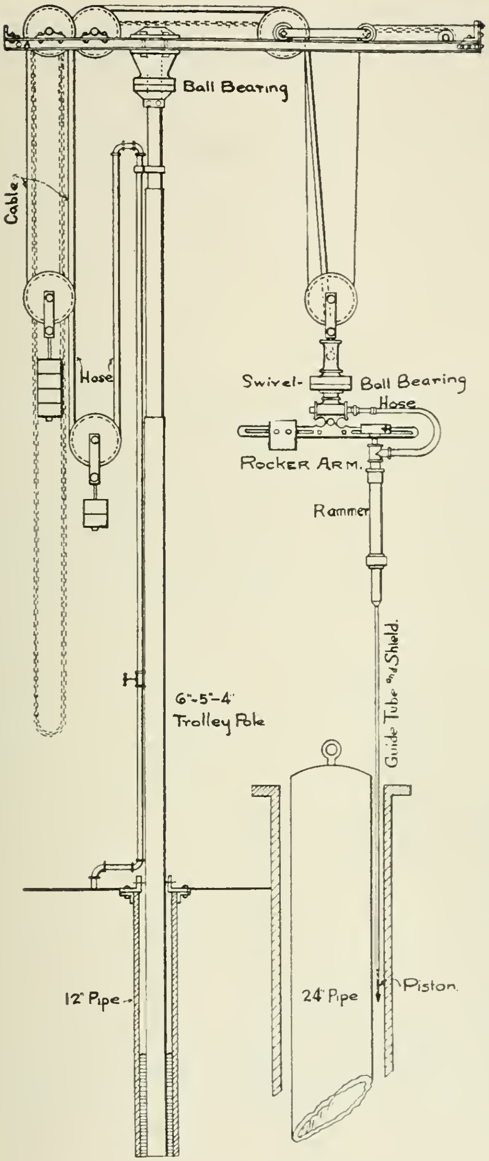
A BALANCED UNIVERSAL PNEUMATIC SAND RAMMER

The cut shows the essential principles of design and construction, and suggests the almost unlimited possibilities of application, of a pneumatic foundry rammer made by the Henderson Engineering and Sales Company, Madison Avenue, New York. Its special line of employment is in the ramming of deep vertical models as for cylinders, pipes, ingot molds, etc. As will be seen the weight of the rammer is always balanced, and it can be moved in all directions not only horizontally but also vertically the balancing of the weight and the ball bearings provided where rotation occurs making all the movements easy for the operator.

The efficiency of the sand rammer has heretofore been seriously limited by the fact that the kick or rebound of the machine has rendered physically impossible the accurate direction of the blows. A most important accomplishment of this machine is the absorbing of the kick or shock of the pneumatic rammer to insure against the displacement of the tool by its own action and permitting the constantly accurate placing of the blows.

The shock absorber is an arm centrally suspended from a pivot on which it vertically rocks. On one end of the arm the pneumatic hammer hangs on a pin permitting it to swing freely horizontally on the line of the arm. On the other end of the arm is rigidly attached a counterweight somewhat lighter than the rammer. The shock or kick of the rammer passes into the rocker arm, which driven upward by the blow is caught by the counterweight, held suspended in the air, and prevented from rebounding against the pneumatic rammer and disturbing the rammer from its position. The rammer, after striking the rocker arm upward drops its weight on the rocker arm and is saved from disturbance from its position by the counterweight arm giving way before it in the same manner as on its upward movement.

The machine as shown in the cut is employed in ramming a deep circular mold as for a water or gas pipe or for a column. A wrought iron trolley pole is provided for the mast of a jib crane. The crane jib, riding on ball bearings, is of I beams which serve as a track for a movable carriage on which are sheaves for the suspension cable and air hose. The suspen-



BALANCED PNEUMATIC SAND RAMMER.

sion cable is tied on the forward end of the jib, passes over a sheave on the forward end of the jib carriage, then down under a riding sheave which supports the air swivel, the shock absorber and the rammer. From the riding sheave the cable passes up over a sheave on the rear end of the jib carriage, then over a sheave on the rear extension of the jib and down under a riding sheave from which is suspended the main counterweight, and then is tied to the rear extension end of the jib. The air hose connecting with the air pipe line at the side of the pole and passing over the jib and the jib carriage sheaves to the air swivel is kept straight by a light counterweight on another riding sheave.

The jib carriage is quickly and easily moved in or out to center over different sizes of molds, by means of an endless chain hanging within the operators reach by the side of the pole, and the freely swinging jib permits the operator to move the rammer practically without effort from one ramming seat to another.

The rammer is provided with an extension piston, or rammer stave, of wrought pipe of suitable size. Attached to the barrel of the rammer is a guide tube inside of which the rammer stave operates. The operator swings the balanced rammer around the circular mold, controlling it by a guide tube which passes upward through his hand as the ramming of the mold progresses. The vertical movement of the rocker arm permits the operator to follow easily any irregularities on the surface of the mold which may occur from the uneven feeding of the sand.

For ramming car wheels or other work that must be rammed where it is to be poured and which cannot be reached by a jib crane, the machine is suspended from a carriage riding on an I beam or other overhead track and moved at will through the shop. To a main supporting carriage thus traveling on an overhead track, is rigidly attached an air swivel which carries a swinging arm. From one end of this non-rocking arm is suspended the riding sheave supporting an air swivel, a shock absorbing rocker arm and a pneumatic rammer. The opposite end of the arm supports the counterweight in the same manner as did the jib of the crane.

The details of applications of this apparatus to different varieties of work will readily suggest themselves without further description.

When the steamer Phyllis recently arrived at the Panama canal zone, her cargo is said to have received even more respectful attention than that of the steamer that shortly before arrived at Colon loaded with congressmen. The Phyllis had aboard 1,032,000 pounds of dynamite.—*Contractor.*

A SPECIAL RAILROAD DITCHER

The accompanying illustrations, adapted from *Engineering News,* will give us a tolerably clear idea of a railroad ditching machine designed by Mr. Ben. Bowman, Springfield, Mo., built for the Southern Pacific Railway and used by it upon its lines in California and elsewhere. The entire apparatus is built upon a flat car, and when in use is towed along the track by a locomotive. As it has to do with the ditches upon both sides of the track, every operative detail upon either side of the car is installed in reverse upon the other side. The machine either makes new ditches entirely or operates upon existing ditches to widen or clean them, as may be required.

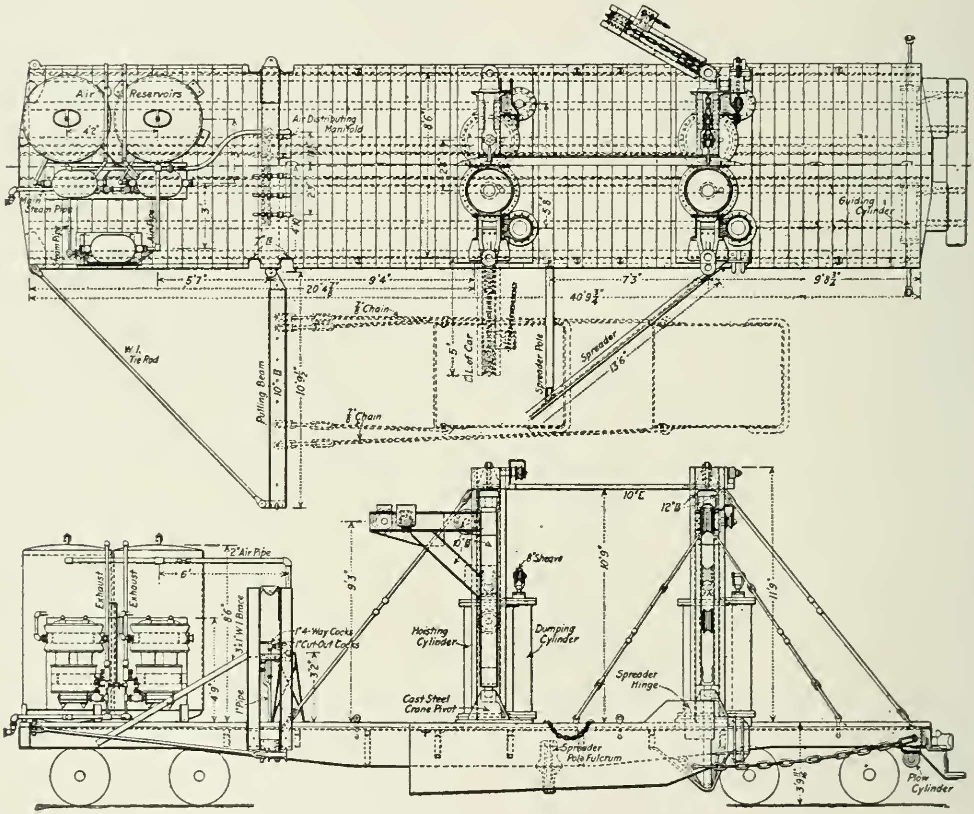


FIG. 1. PLAN AND ELEVATION OF RAILROAD DITCHER.

THE PNEUMATIC CRANES.

There are two pneumatic cranes upon each side of the car, these cranes standing out at right angles to the car when in use and swinging back out of the way for the operations in which they are not used. The illustrations show the cranes in different positions. The function of the cranes is to raise and dump the scoops and to assist in guiding the plow and sloper. The air cylinders for the hoists are in the center of the car between the cranes. For each crane there is a large cylinder to operate the main hoist and a smaller one for the auxiliary hoist used in dumping the scoops. The compressed air is supplied by three air brake pumps which, together with the two vertical air receivers, are mounted on the forward part of the car. Steam for the pumps is taken by a hose from the attendant locomotive. The operation of the various hoists is controlled by one man at the air distributing manifold. Besides the eight hoisting cylinders there are also two horizontal plow-guiding cylinders under the rear end of the car.

THE PLOW.

The plow is shown in operation in Fig. 3. It is hung from the main chain of the rear crane, which controls its working depth, and its line of action is controlled by the guiding cylinder acting through a steel pole attached at the rear of the plow-beam. A second steel pole projects from a fixed bracket on the side of the car and is attached to the plow-beam near its forward end. This pole has a universal joint at the bracket so that it can follow any vertical or horizontal movement of the plow. A pulling cable passes from the forward end of the plow-beam to its fastening on the forward corner of the car.

The pole projecting from the bracket on the car body acts as a distance rod or strut to hold the plow to its course against the lateral component of the pull in the cable. The outer end of the pole serves as the fulcrum about which the plow turns under the action of the guiding pole. A considerable range of working disdistance from the track is attainable with one length of pole by varying the length of the pulling cable, but the pole is made in two parts, one telescoping within the other so that its effective length may be changed to permit a wider range of working distances.

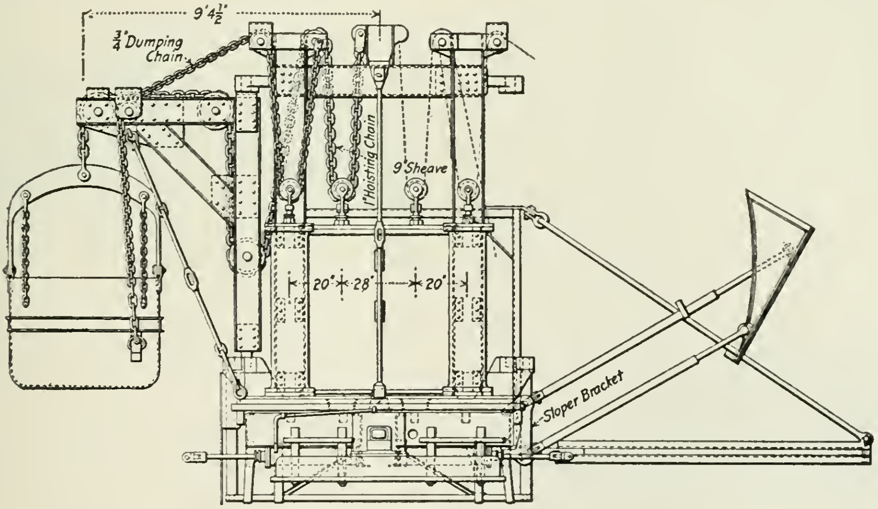


FIG. 2. FRONT END ELEVATION OF DITCHER.

THE SCOOPS.

The material loosened by the plows is collected by the scoops as shown in Fig. 4. There are two scoops for each side of the car, one being handled by each of the four cranes, and each scoop has a capacity of 4 cu. yds. They are so hung that when lifted, after having been drawn through the loose material and loaded, they will tilt backward, and this tilting is restricted by chains connecting the bale of each scoop to its back wall. The loaded scoops are hoisted by the main crane cylinders through a single chain attached to the bale. The dumping chain, fastened to the back of the scoop, is operated by the smaller auxiliary hoist.

The scoops are dragged through the material loosened by the plow by chains leading to the pulling beam. There are two chains for each scoop, attached one on each side at the front near the bottom. The pulling beam is shown in the half tones and in the plan, Fig. 1. The chains are coupled to the beam by vertical pins passed through holes in the channels and through the coupling link between. The beam extends out about 10¾ ft. from the side of the car body and is provided with a number of coupler holes so that the scoop chains can be attached at any point as desired in working at different distances from the track.

The beam has a pin joint, or hinge, at its junction with the car body and the tensional component of the pulling strain is taken by a diagonal tie rod from the outer end of the beam to the forward corner of the car. When not in use, the tie rod is disconnected and the beam is swung in forward against the car body. A second tie rod passes from the end of the beam to the top of the rectangular frame above the manifold and supports the beam's weight.

THE SLOPER.

The sloper is pulled by this same beam and is attached to it by a cable and leading chain, as shown in Fig. 5. It consists simply of a flat laminated steel plate about 4 ft. square to which is riveted a curved plate flaring away from it at the rear to act like the mold board of a plow. No guiding pole is used with the sloper, but there are two fulcrum poles universally jointed to their bracket on the car body and attached to the sloper, as shown in the end elevation, Fig. 2. By changing the relative lengths of these poles, it is possible to change the angle of the bank the sloper cuts.

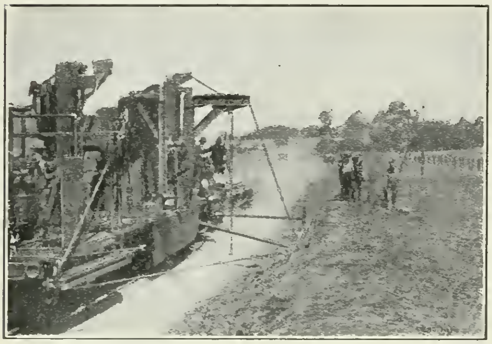


FIG. 3. PLOWING HARD EARTH.

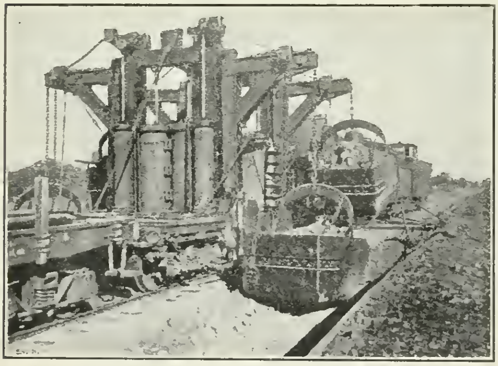


FIG 4. THE SCOOPS AFTER THE PLOW.

As shown in Fig. 5, the working position of the sloper is controlled by the main chain of the rear crane, from which it is hung.

THE SPREADER.

The spreader is shown in Fig. 1 (plan) in its working position, swung out to an agle of about 40° with the direction of motion. It is held in this position by a bracing pole extending out from the frame of the car. When not in use, the pole is removed and the spreader can be swung back on its hinge until flat against the car body. The spreader is used in distributing dumped material to give an even surface to fills alongside the track.

In using the ditcher, the first operation is to break up the ground with the plow. Then the scoops are put in position and pulled through the loose material by means of the locomotive. The filled scoops are lifted by the pneumatic cranes and the locomotive tows the ditcher to the dumping place. When necessary, the dumped material is leveled off by the spreader. The ditcher is then returned to the cut and the final slope of bank is obtained with the sloper. The scoops may again be necessary.

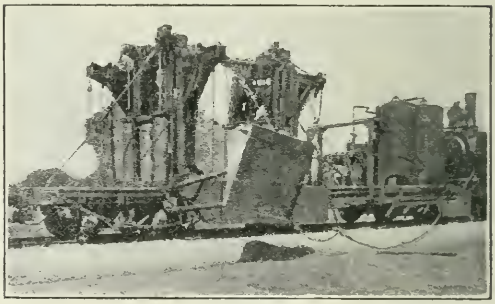
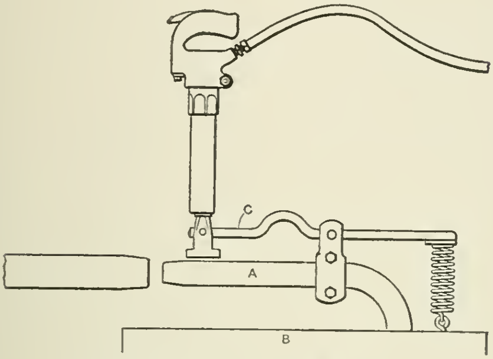


FIG. 5. SLOPER READY FOR USE.

During the preliminary tests of the ditcher it was tried out on the material of the California foot hills in midsummer when the soil was baked to nearly the consistency of hardpan. Under these conditions, and when the operations of plowing, sloping, hauling and spreading were all required, a total of 360 cu. yds. was removed in six hours. This was done in 30 loads, with an average travel of 1,200 ft. from cut to dump.

FLUE WELDING WITH A PNEUMATIC HAMMER

An inexpensive flue-welding device that was designed to handle a large repair job that came in unexpectedly is shown in the accompanying illustration. It consists of a mandrel *A*, which is attached to a cast iron block *B*, and a pneumatic hammer (equipped with a swage), which is mounted on a lever *C*. As the illustration shows, this arm is fulcrumed to a bracket on the mandrel and is spring supported. The ends of the long pieces were first scarfed by lowering the back end of the tube until it was about six inches below the level of the mandrel. This gave a taper of approximately ¼ inch to the inch. After all the long pieces were scarfed, short pieces about 8 inches long were placed in the furnace and heated on one end so that they could be drawn to a feather edge. This also was done under the pneumatic hammer. After all the flues were scarfed and the short ends made ready for welding, the horse upon which the outer ends of the flues had rested, was raised to bring the work level with the mandrel. All short pieces were then put on the flues while hot so they would shrink tightly in place, thus insuring a good clean weld by preventing any dirt from getting between the surfaces to be welded. After all flues were treated in this way the furnace was cleaned, and the welding done at a speed which would make many of the costly flue-welding machines hustle to keep up with.—*Machinery.*



FLUE WELDING ARRANGEMENT.

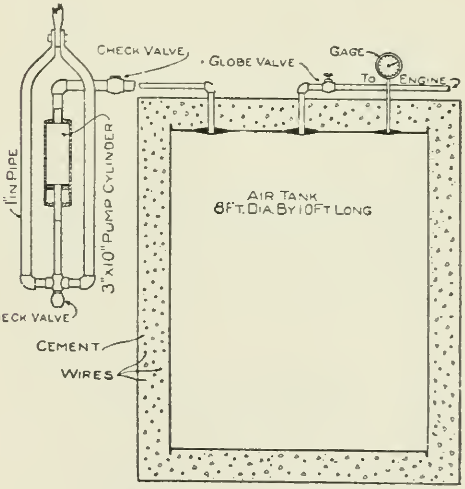
A WINDMILL AIR COMPRESSOR

C. L. Perrin, Kerhoven, Minnesota, tells in Popular Mechanics how he worked out a practical and cheaply operated compressed air service for his little shop. He says:

There are some tools in nearly every blacksmith shop, no matter how small, that require a steady power of some kind or other to run. I had a small steam engine for a while, but soon found that I did not use it enough to pay me to keep up steam.

I then built myself a windmill, thinking that it would be cheaper than a gas engine, but the power it gave would not run the tools at a steady speed. The sketch shows how I finally won out and used both my windmill and steam engine.

I made an air pump which worked similar to an ordinary bicycle pump. Having a 3 by 10-in. pump cylinder on hand I made a piston for it, using a 1-in. gas pipe for a rod and a leather washer held between two flanges on one end of the rod for a plunger head. On the other end of the rod I screwed a 4-way pipe coupling and into this a nipple and vertical check valve as shown in the sketch. I then connected two upright pipes to the side openings of the 4-way coupling by means of elbows and nipples. The nipples I filled with lead to make them air-tight. The upright pipes are bent together at the top and flattened so as to make a connection for the pump rod of the windmill. On the top end of the cylinder is attached a pipe, with a check valve in it, and connected to a large air tank which I had a tinner make of heavy galvanized sheet iron. The tank is 8 ft. in diameter and 10 ft. long and is reinforced with concrete and heavy wire. A pipe line with a globe valve in it connects the tank to the engine. A gauge is also attached to register the air pressure. The pipes are fastened to the tank with heavy flanges.



WINDMILL AIR COMPRESSOR.

The windmill which I made myself has a 16-ft. wheel and develops power enough to put 80 lb. air pressure in the tank and that pressure easily runs my 3-hp. steam engine. The tank fills about as fast as I use the air, thus I am able to run my engine for several hours at a time with practically no cost at all. The engine is well packed so as to utilize all the air with as little waste as possible.

Number of tools		1	5	10	15	20	25	30	35	40	45	50
	Diameter Stroke.											
Chipping Hammers.	$1\frac{1}{8}$″x1″	14 2.6	69 13	134 25	197 37	258 48	315 59	370 69	421 79	470 88	517 96	560 104
	$1\frac{1}{8}$″x2″	17 3.2	18 16	163 30	240 45	313 58	383 71	449 84	512 95	571 106	627 117	680 127
	$1\frac{1}{8}$″x3″	20 3.7	98 18	192 36	282 52	368 69	450 84	528 98	602 112	672 125	738 137	800 149
	$1\frac{1}{8}$″x4″	22 4.1	108 20	211 39	310 58	405 75	495 92	581 108	662 123	739 138	812 151	880 164
	$1\frac{1}{8}$″x5″	25 4.7	123 23	240 45	353 66	460 86	560 105	660 123	753 140	840 156	923 172	1000 186
Riveters.	$1\frac{3}{16}$″x6″	33 6.1	162 30	317 59	465 87	607 113	743 138	875 162	993 165	1109 206	1218 227	1320 246
	$1\frac{3}{16}$″x8″	36 6.7	176 33	346 64	508 95	662 123	810 161	950 177	1084 202	1210 225	1328 247	1440 268
	$1\frac{3}{16}$″x9″	38 7.1	186 35	365 68	536 100	699 130	855 159	1003 187	1144 213	1277 238	1402 261	1520 283

Large figures are free air and small figures are horsepower to drive compressor. Figures for air are for 80 pounds pressure at sea level, and are based on ordinary intermittent service as is usual in any shop. Ratings for one hammer are actual readings from water displacement tests, being averages of many trials. Horsepower figures assume compound air compression to 85 pounds pressure and include friction. For single stage compression to 85 pounds add 15 per cent to power figures. Compressor displacement required should include volumetric loss as figures are for actual air delivered.

TABLE OF PNEUMATIC HAMMER AIR CONSUMPTION.

AIR AND POWER REQIREMENTS OF PNEUMATIC HAMMERS

It is to be regretted that, through a mistaken policy in the beginning, many of the manufacturers of pneumatic tools have heretofore resorted to the publication of what are really "nominal ratings" for the cubic feet of air required to drive their machines. This condition of affairs is similar to that in the automobile business, where a tendency to overrate the engine power in many cases is well known. The excuse for such procedure is that the other fellow does it, and consequently if any manufacturer has the backbone to give the real figures, his machines will not compare so favorably on paper with those of his competitor.

Some measure of excuse may be granted when it is said that most of the figures given for air required to drive pneumatic tools are based upon calculation and estimation only, as the actual measurement of the air required to drive any machine is a little difficult to accomplish without special apparatus. As a matter of fact pneumatic tools of different makes do not vary a great deal in their air consumption for a given amount of work done, and so, for estimation purposes for the installation of a suitable compressor, the figures given in the accompanying table are of timely interest.

In this table are given the actual cubic feet of free air required per minute and the power to operate from one to fifty pneumatic hammers of the cylinder diameters and strokes shown. The quantities of free air for one tool have been obtained by careful experimenters with special water-displacement apparatus, and being the averages of a great many readings, may be taken as accurate and fairly representative for most tools of similar dimensions. The figures for more than one tool were obtained by deducting 2 per cent. for every five tools; that is, five chipping hammers are assumed to require 4.8 times as much air as one chipping hammer of equal size. Ten hammers are assumed to require 9.6 times as much as one hammer, and so on. This is to allow for the intermittent action of different tools in a shop, and this basis of calculation agrees very nicely with observed shop practice.

The quantities of air, as shown by the larger figures in the table, are actual cubic feet of free air required at atmospheric pressure at sea level, this air being delivered to the tool at 80 pounds pressure. The figures for horsepower, which are the smaller figures in the table, assume compound compression to 85 pounds pressure; that is, allowing 5 pounds drop in the pipe line. The figures for power also include reasonable friction of the compressor and the usual losses of power in the air cylinder of an air compressor of reasonably good design. They would represent just about the brake horsepower required from an electric motor to drive a compressor actually delivering the quantity of air given by the large figures above them.

This brings up the point of the volumetric efficiency of the compressor. As the quantities shown were obtained by actual measurement of air used, it is imperative that the output of the compressor shall be equal to this. To allow for volumetric efficiency loss, this necessitates that the piston displacement of the compressor shall be greater than these figures by from 8 to 12 per cent., depending upon its design. The figures for power required include this loss, as they represent the power necessary to actually deliver the quantities of air shown as the actual output of the compressor.

In cases where single-stage compression is used the power required may be obtained by adding about 15 per cent. to the power figures given. This, of course, has no effect upon the air quantity.

It has been stated that these figures are for sea-level operation. This will be satisfactory for most localities, but at 5,000 feet elevation 17 per cent. more free air capacity will be required and about 7 per cent. more horsepower, for the same size and number of tools. These increases are practically proportional to the altitude.—*S. B. R., in American Machinist.*

Be thankful every morning when you get up that you have something to do that day which must be done whether you like or not.—*Kingsley.*

A TRANSCONTINENTAL TUNNEL

The tunnel up in the Andes which is to connect the Argentine and the Chilian railways is now approaching completion, and next year trains may run across South America from the Atlantic to the Pacific. The tunnel is comparatively short, being little more than two miles, but the undertaking has been a difficult one, not only from the nature of the rock, but because the work was so far from civilization, and especially on account of the altitude, 10,000 feet above sea level, or more than twice the height of Ben Nevis. It may easily be imagined by those who have climbed in the Alps how much physical discomfort has had to be endured by the engineers and their men. We may well believe that without the air compressor, the rock drill and the pneumatic locomotive the task would never have been accomplished.

It is twenty-two years since work was begun at Mendoza on the Argentine side of the great enterprise of crossing the Andes. Step by step the lines have been carried further and further up the mountain valleys from both sides, but even now the traveller has to spend a day on mule-back and in a coach in crossing the pass from the Argentine to the Chilian rail-head—a toilsome though attractive trip that is not possible in winter. When the tunnel is open for traffic the day's weary journey will be reduced to an hour in a comfortable railway carriage, and Valparaiso should be brought within two days of Buenos Ayres. Travellers will gain much by the improvement, and communication between the neighbor republics will be as easy as it has been difficult hitherto. The tide of immigration may be expected no longer to stop in the Argentine, but to flow on to Chile, now that the long and often stormy passage round the Horn may be avoided. It is possible, too, that the Chilians may develop a large export trade overland through Buenos Ayres. The wealth of their country has not yet been properly exploited, because with all their energy the Chilians are geographically on the wrong side of South America. But with the continuation of the splendid Argentine railway system into Chile a great awakening should come for that vigorous little Republic.

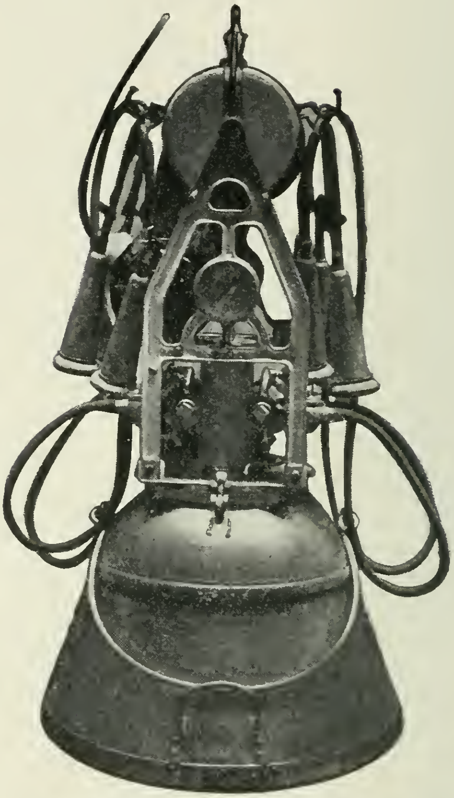
NAPOLEON AND THE VACUUM PROCESS OF FOOD PRESERVATION

It is not generally known that Napoleon Bonaparte was the first promoter of the modern process of canning foods. Records of the French Academy of Science lately brought to light in Paris tell the story.

The French nation was strenuously voicing its disgust at the manner in which the "Little Corporal's" soldiers were compelled to carry their food and to eat it on the march, and Napoleon directed the Academy to offer a prize of 12,000 francs to the man who could keep foods indefinitely in their natural preservations.

Nicholas Appert won the 12,000 francs. He discovered what has since been perfected into the present-day method of canning, for he simply inclosed the food in airtight containers and subjected the whole to such a degree of heat that the contents received a thorough sterlization. The vessels which Appert used were clumsy. He was handicapped in his efforts by poor utensils. However, he originated the fundamental principle which is used in American canneries today. Now, however, in place of Appert's crude vessels, fruits, vegetables and the like are placed in bright, new, clean cans, which are made airtight. The second division of the process is the subjection of the cans to intense heat. Boiling water at a temperature of 212 degrees Fahrenheit is the natural sterilizer in which thousands upon thousands of cans are allowed to stand for a given length of time. If cooked by steam or in a retort at from 240 to 260 degrees or more, the product is not given as long a period of sterlization. Science, since Appert's day, has determined the length of time necessary. The operation is simple yet the process is all-important. Nothing more than the heat treatment is necessary to keep the delicacies in a pure state for years.

The heating of the can and contents for sterlization is taken advantage of to secure the perfect exclusion of the air. The can being filled as full as possible with the material to be preserved the little space remaining is occupied by steam, and the sealing of the can while hot, by soldering or otherwise, and the subsequent condensation of the steam within leaves a practically perfect vacuum. The process is so entirely successful that there is no necessity to-day for the chemical preservatives formerly used, and there is no longer any incentive for the introduction of foreign substances.



AN ELECTRO-PNEUMATIC MILKING MACHINE

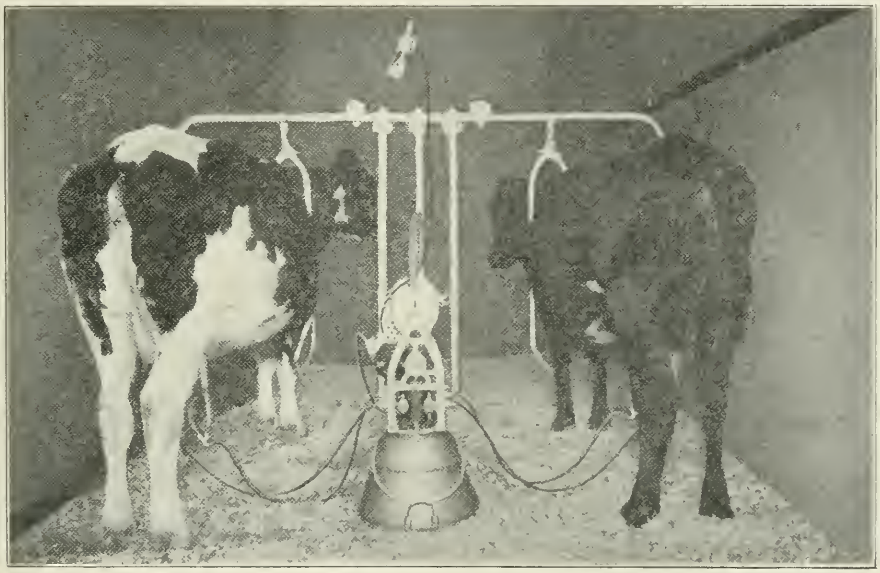
The accompanying half tones show us the Liberty Cow Milker, manufactured by the Liberty Cow Milker Company, Hammond, Ind. The actual status of this so called "electric" machine is quite similar to that of the Electric Air rock drill, in that it provides a new field of employment for the electric motor to give life to the aparatus, while the ultimate operation is essentially and exclusively pneumatic.

The milker consists of two essential parts: the milk can or receptacle and the milking machine proper. The cans are made alike and are duplicated so that the machine can be removed from one to another. The base of the machine forms the cover for the can, fitting upon it and making an air tight joint with a rubber gasket. There is a little motor geared to a crank-shaft and two vacuum pumps which run constantly when the machine is in use and maintain a vacuum in the can. The amount of vacuum in the can is indicated by a gage at the side and this vacuum can be regulated by a needle valve, the pumps normally giving somewhat more vacuum than is required.

Essential parts of the apparatus are a pair of double valves operated by a reducing motion from the crank shaft, which work intermittently at regular intervals. Each double valve is equipped with a stopcock and a rubber tube of sufficient length and a transparent and flexible connection with shut-off clippers to a pair of teat cups carrying pneumatic cushions. The valve is so constructed that in one position a hollow cylinder connects the can vacuum with the teat cup, and in the second position it breaks the vacuum and opens to the atmosphere. After this operation is completed suction is again applied and milk is drawn, the cycle of operation being continuously repeated. This intermittent use of the vacuum and its release imitates the sucking of the calf and its intermittent taking of breath and swallowing of the milk.

TO KNOW WHEN THE COW IS MILKED.

Beneath each teat cup is a small glass tube, where can be seen the flow of milk, and a small shut-off clip. This clip will collapse the tubing and thereby shut off the vacuum, so that when there is no milk flowing from the teat, the clip can be closed and the teat cup taken off so that the test will not be kept under vacuum longer than is necessary. It has been noticed that a calf as well as a hand milker milks the right and the left sections of the udder alternately, and a cow will give down her milk more freely if milked thus alternately than if the milk is drawn from all four teats at once. It is known that often in one section of the udder there is a larger accumulation of milk than in the other. This machine is so constructed that when suction is applied to, say, the right hand teats and their milk is being drawn, the two left hand teats are released so that milk may be accumulating in them. At the next operation milk is drawn from the two left hand teats and so on, milk being never drawn from all four teats at the same time.



MACHINE MILKING TWO COWS.

As will be seen from the half tone, the machine milks two cows at once, and one man can look after five machines. It is said that within a very short time the cows become accustomed to the machine, and as this process is more after the process of nature, the cows feel more comfortable and seem to enjoy this way better than hand milking. The milk, it will be noticed, passes from the cow into the can without exposure to the atmosphere, which is coming to be recognized as a necessary sanitary precaution. The machine can of course be operated in a barn or shed or in the yard, wherever the wires can be led to it.

A NEW SMOKE CONSUMER

A device for consuming smoke, or rather for preventing the production of smoke, is being marketed in Great Britain. The device is practically an extra grate composed of perforated asbestos and fireclay blocks. This is built behind the ordinary grate, and is proportioned so as to give an intense temperature to the air required for perfect combustion. The smoke and unconsumed gases passing from the fire-grate are retarded by the extra grate, and igniting give flame instead of passing into the boiler flues as a mixture of smoke and unconsumed gases. No holes and no steam jets are made in the boiler. The apparatus works automatically, and can be turned on or off by moving a lever below the door of the furnace. The effectiveness of the system was demonstrated at a recent test in a Glasgow oil and paint mill. The fire was coaled with ordinary furnace fuel, and it was allowed to burn for a few minutes without the coal-consuming apparatus being in operation. Black smoke issued from the chimney in copious quantities. Then the apparatus was applied, and within forty seconds—the time required to allow the flues to clear—not the slightest semblance of smoke was to be seen at the mouth of the chimney.

A HIGHWAY TUNNEL THROUGH MISSIONARY RIDGE

A tunnel, 700 ft. long, in hard rock, now more than half completed, is being driven through Missionary Ridge, near Chattanooga, Tenn., which will save the traffic over the ridge, a long detour and a hard climb. The base has been driven about 400 feet from the west or lower portal, the tunnel having a grade of 5 per cent. thus affording natural drainage during the progress of the work. The rock is a hard blue limestone, in strata inclined about 45 degrees. The tunnel base is about 36 feet wide and 26 ft. high, and lined with masonry. The excavation is conducted by first removing a top heading 8 ft. high for an advance of 10 ft., then timbering with segmental timbering and finally removing the bench, no wall timbering being required. The drilling plant consists of a 70 horse power marine boiler located near the portal with a 12x16 in. Ingersoll Rand compressor operated at 110 lbs. gage pressure and four drills made by the same firm. A full account of the work with several interesting half tones is given in a recent issue of *The Contractor.*

ACETYLENE LAMPS FOR MINERS

Acetylene lamps consume about one-fifth as much oxygen as candles do to give the same amount of light. On that account, when it is necessary to work in badly ventilated stopes or headings, acetylene lamps should be used, not only because they consume less oxygen, but also because they give a bright light in air in which it is difficult to make a candle burn. Acetylene lamps are now made small enough to be worn on a miner's hat; they are used at the Saginaw mine on the Menominee range, Michigan. While the lamps require some attention in order to keep the water feeding properly to the carbide, the miners soon learn how to care for them. The lamps then give little trouble. It is said that it costs about two-thirds as much for light when acetylene lamps are used as against candles. At the Michigan mine the cost of the carbide required to last a 10-hour shift is about 2 cents.

GROWTH OF THE GAS ENGINE

In a bulletin of the United States Geological Survey recently issued it is said that the internal combustion engine has already become a serious rival of the steam engine in many of its applications, and that the development of the large gas engine especially has within the last few years been extremely rapid. Only nine years ago a 600 h. p. engine exhibited at the Paris Exposition was regarded as a wonder, but to-day four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 h. p. can be found in nearly all well-equipped steel plants, and some plants in this country contain several units rated at 5,400 h. p. each. More than 500 producer gas power plants, ranging in size from 15 to 6,000 h. p. are now in operation in the United States, about 88 per cent. of them running on anthracite coal.

COMPRESSED AIR
MAGAZINE

EVERYTHING PNEUMATIC
Established 1896

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FRANK RICHARDS, - - Managing Editor
L. I. WIGHTMAN, - - - Business Manager
H. L. KEELY, - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. MARCH, 1910. No. 3

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THE MAKING OF ROCK TUNNELING RECORDS

In the preceding issue of COMPRESSED AIR MAGAZINE we presented an abstract of an interesting paper, first published in the *Engineering Record,* giving an account of the work in the Rondout tunnel of the Catskill aqueduct system, and the recent making there of a remarkable time record on tunnel driving. As a contribution to the discussion of the means and methods by which rock tunneling records are being made, both in the United States and in Europe, we reprint the following letter to the editor of the *Engineering Record*:

Sir: The record of progress in tunnel driving made by the T. A. Gillespie Company on the Catskill Aqueduct, described so clearly in the *Engineering Record* of Jan. 1, is a valuable contribution to the archives of tunnel progress in America. We read a great many statements in the newspapers and in some scientific publications about remarkable tunnel progress, but when the cases are analyzed certain favorable conditions are discovered which account for the progress and which so far affect the case in comparison with other tunnels as to make the record valueless. The first point usually discovered is that the rock is not rock at all. I have in mind a recent widely published tunneling record where the progress was so extraordinary that I was induced to examine the case on the ground, and found that the holes in the headings were being bored by an auger and that much of the work was done by steam shovels.

The record made by the Gillespie Company in the Rondout pressure tunnel belongs to rock tunneling records, and in this respect it may be compared with the Simplon, Loetschberg and other well-known tunnels. Tunnel driving when progress is considered, is usually a matter of heading driving; that is, one naturally asks after reading a record, what is the diameter of the tunnel driven? This, of course, has some influence in driving a heading. A large diameter of tunnel, for instance, large enough to admit of the use of steam shovels for removing the muck, might materially aid the heading progress, because after tunnels reach diameters of 10 ft. and over the best practice is to drive a pilot heading, followed by a bench, and the more room one has from the bench line to the portal the easier it should be to get rid of the material.

Tunnel headings are driven of such height and width as will best admit of the proper handling of the machinery. It would be a mistake, for instance, to drive a heading 5 ft. by 6 ft. where a tunnel of larger dimensions is wanted, because machinery cannot be used to advantage in so small a heading. It is, therefore, the usual practice to make the height of the heading only sufficient to clear the heads of the men or say 6½ to 7 ft. and the width from 9 to 12 ft. We may, therefore, place all rock headings where the dimensions of the completed tunnel are larger than the heading dimensions in one class when comparing progress.

The record made by the Gillespie Company, 488½ ft. in 30 days, representing a daily average of over 16 ft, closely approaches the remarkable records made in the Alpine tunnels, notably at Simplon and Loetschberg. It is generally admitted that Alpine tunnel progress has been unsurpassed anywhere in the world when a fair comparison is made of heading driving in solid rock. Alpine tunnel progress has reached 1 ft. per hour or 24 ft. per day, daily averages from month to month being from 18 to 20 ft.

In view of the fact that the same rock drills were used at Rondout as at Lotschberg, it would seem reasonable to say that the difference is due to the system employed, but as that difference is not great one would hardly advise Messrs. Gillespie to make any changes in the methods of work.

An important factor, which is a part of the system of Alpine tunnel driving, is that the rock is broken up fine and this, I think, accounts for the Rondout record, where I am very much inclined to believe, from the descriptions given, the rock is broken up fine and blown as far as possible away from the face of the heading. It is obvious that where the cut-holes and side-rounds simply break large chunks of rock which fall at the face considerable difficulty will be experienced in getting the drills at work, while with finer material and heavier blasts, which means a greater number of holes and more powder, access to the face of the heading may be accomplished in less time and the drills put promptly to work. While it is a common statement that the problem in tunnel progress is to get rid of the muck, it must not be forgotten that to get the drills at work quickly after the blast is of the greatest importance, because the quicker they get to work, and the better they work, the greater number of holes may be driven in the face, and the finer the material may be broken. This simplifies the problem of mucking.

W. L. SAUNDERS.

COMPRESSED AIR, THE TIME AND COST SAVER

It is curious to note the course of the modern acceptance and the later spreading and accelerating adoption of compressed air as a means of power transmission and application. Its life-work may be said to have begun only half a century ago in driving rock drills for tunneling and mining. Here, of course, its use was, in a sense, compulsory, and its earlier friends and would-be promoters spent more time than it was wise to do in explaining and apologizing for the power losses involved in its use, inviting the assumption that, therefore, compressed air could never have much to do in other lines.

The air brake developed another extensive field of great usefulness, in which compressed air was most indispensable. Then the presence of a spare air-brake pump in every railroad shop, and the readiness with which a small supply of compressed air could thus be obtained led to the invention of many varieties of labour-saving devices, so that compressed air soon came to be in demand, particularly for its handiness and its ever readiness, entirely ignoring its power cost, even when supplied by the steam gormandizing air-brake pump.

This bugbear of the waste of power in compressed air practice is rapidly disappearing. At the present time, since engineers of the larger type are acquiring the habit of thinking compressed air, compressors in large units are being installed for doing work formerly monopolized by steam, and simply because air is ultimately much the cheaper. In extensive outdoor operations, where there are a number of isolated and widely separated machines, usually steam-driven, it saves steams, saves labour, secures more uninterrupted and reliable service, to install a central air compressing plant and to drive everything with the air.

Say that a dam is to be built in one of our larger rivers for the development of a great water-power. The most approved and up-to-date practice is, first of all, to place a compressor plant of computed capacity, not neglecting the possible economies in the details of it, and to lay the main pipe lines. In one such case the free air capacity was 5,000 cubic feet per minute. The air is then used as it is needed, not only for the rock drills, if any are enployed, but for practically all the other work, for driving the augers in building cofferdams, for concrete mixers, for traveling pelicans depositing concrete, for derricks and other hoists, for cable conveyors, etc. The air also is used to drive the various tools in the machine shop, the blacksmith shop and the carpenter shop, which are the busy adjuncts of such a plant.

Typical employments of compressed air in the larger way were in the vast excavations required for the Pennsylvania Railroad terminal and the New York Central Railroad stations in New York City. All the power for all the apparatus employed on this work could have been supplied by steam direct, yet steam was only used to drive the air compressors, and the work was then ultimately done by the air.

The drive of the compressors for these large installations will be determined by the individual conditions; sometimes it will be steam, sometimes water power,; and sometimes there will be a direct connected electric motor, the current coming from steam or water, and in the latter case often from a considerable distance.

The air plant for one of the contracts on the Barge Canal is situated close to a main line of railroad, so that it is easy to deliver coal to it, and this is accordingly a steam-driven plant. The work of another contractor only a few miles from this is nearly as far from the railroad, and the compressors there are driven by direct-connected electric motors, the current being conveyed under high voltage some 20 miles from a water power on the upper Hudson.

A repairing shipyard, probably of the largest total capacity on the Atlantic coast, requires a large supply of compressed air for operating the pneumatic tools and other devices, compressors with direct connected electric motors being employed, the pumps for unwatering the drydocks being also so driven. As the power requirements are here quite irregular it was found better to take current from one of the Edison electric stations rather than to instal in the yard a power plant sufficient for maximum demands. This is an old shipyard modernly equipped; if it were to be designed and built entirely new we could suggest that the air lift should be employed for unwatering the drydocks, and then compressed air could do all the work of the yard.

The electric transmission of power which is later transformed into compressed air power for the actual doing of the work, adds much to the electric power totals, and illustrates how beautifully these two rivals work together to the advantage of both.

COAL MINE FATALITIES

Editor Compresed Air Magazine:

On Compressed Air Magazine, January, 1910, page 5518, the statement is made that 90 per cent. of all deaths in mines are caused by suffocation. In 1906, the last year whose statistics are available, only 15 per cent. of the coal mine deaths were from explosions of all classes, including gas, dust and powder, so probably not 5 per cent. lost their lives through suffocation. The great cause of accident is falling roof, which alone accounted for 50 per cent. of the coal mine fatalities.

R. V. Norris, E. M.

Wilkesbarre, Pa.

[The regrettable error of statement referred to was adopted from an eminently respectable source without sufficient scrutiny. In confirmation of Mr. Norris we have the following from the Director of the United States Geological Survey, Washington, D. C.—Ed. C. A. M.]

The statement in your magazine to the effect that 90 per cent. of the deaths in coal mines occur from suffocation must have been meant to apply only to the great disasters which have occurred in the various mines in recent years. The statement made by your correspondent that in the year 1906, fifteen per cent. of the deaths in coal mines resulted from explosions of all classes, and that fifty per cent. of the coal mine fatalities were caused by fall of roof is correct. These statistics were evidently obtained from a bulletin published by the Survey. Mr. Hall states that from his personal observations he believes that ninety per cent. of the lives lost in the Monongah, Dorr, Naomi, and Yolande disasters, which cost the lives of nearly 700 men, were due to suffocation.

SELF-EXAMINATION FOR YOUNG MINING ENGINEERS

The student of a school of mines should look squarely in the face the facts and circumstances he is likely to or sure to meet with in his mining career after leaving college. We would suggest, for example, that he ask himself such questions as these:

1. Can you cook and set out a good "square" meal with or without the help of some of the men of a mining boarding house in case the cook is ill or leaves suddenly?

2. Can you take charge of and run a boarding house, contract for supplies and lay in store for the winter months and keep accounts yourself.

3. Can you do blacksmithing, sharpen a drill or pick, and do you know the right "color" of tempered steel for certain kinds of rock?

4. Can you do ordinary mine timbering, and do you know when it is well done, or not, by others?

5. Can you swing a hammer, drive drills, blast, etc.?

6. Can you manage men and get along with them and get the proper amount of work out of them?

7. Are you a fair judge of a vein or ore body, and can you form a shrewd idea of its course and how to develop it and how to trace it?

8. Can you give "first aid" in case of an accident, and do you know anything about medicines and practical surgery?

9. Do you know about noxious gases and how to deal with them and how to manage the ventilation of a mine?

10. Can you survey a mine inside and out and assay?

11. Can you keep systematic mining accounts?

12. Are you a judge of the best methods of milling the ores and could you run and manage a mill?

13. Are you well versed in mining and electric machinery? Could you superintend the erection of a hoist, etc.?

14. Can you make mining maps and sections showing the amount of ore stoped out, in view or probable, and where assays have been taken and send in a report to the company that will be intelligible to them?—*Mining Science.*

A MINING ENGINEER ON SKATES

The mining engineer is in Nova Scotia and the skates are native fishes upon which he made a report. He observed that during the lobsters' molting season, the mud flats of Nova Scotia were infested with thousands upon thousands of skate, and that each one dissected contained fragmentary lobster. The government experts who previous to this discovery claimed that the dogfish was the murderer, have now decreed that henceforth the skate shall be converted into fertilizer and glue, which it is hoped will reduce the pest to cash, preserve the lobster and reduce it to more cash.

Up in the country a gasoline engine driving a wood sawing outfit began to run hard and finally wouldn't go at all. A machinist found the cylinder pretty well filled with a hard substance which he decided was burned sugar. The engine had been oiled with a can of maple syrup.

SAFETY IN THE SUBMARINE

It is far from impossible for modern inventors to produce a vessel which may be made to submerge itself at will and to rise again as required, to provide means for its propulsion and manipulation and for performing acts of offensive warfare such as the launching of torpedoes, but the most imperative requirement of all, the guaranteeing of a probability of safety to these who are to operate it under conditions which must inevitably arise in service is the least promising of attainment. Some of the latest developments in this line are talked of in a recent issue of an English publication.

It is pointed out that the crew while in the submarine must be independent of poisonous gases which might be accidentally generated by the leaking in of salt water or otherwise; they must be preserved from drowning while in the boat; means of escape and of rising to the surface must be provided. The devices at present known are air locks for escape, detachable chambers or life boats and self contained dresses. Air locks alone are of little use except in shallow water, but combined either with detachable chambers or with self-contained dresses, they are essential in all methods of escape. When a submarine is holed by accident, the water pouring in will, if the hole be at the top of the boat, gradually replace the whole of the air in the vessel; but if the hole be below the highest point, then the water as it enters will compress the air until the pressure of the latter is equal to that of the water outside. It is obviously necessary, therefore, to provide some device that will catch and contain the air if the vessel be holed high up; hence the provision of air-traps. The accident having taken place, and the boat having sunk to the bottom, air will be compressed either under the deck of the vessel itself or under the air-traps. Beneath the air-traps the men, having put on their special diving-helmets, sit, with their heads in the compressed air, until it is their turn to escape, either through the conning-tower or through the torpedo-hatch, and rise to the surface. In front of the water-proof jacket, attached to the diving-helmet, is a pocket containing a combined purifier and oxygen-generator, which enables the same air, purified and reoxygenated, to be used again and again. The dress, which can be put on in thirty seconds, not only prevents the suffocation of the wearer, but acts as a life-buoy. There are fitted to the air-traps air-supply pipes from the boat's compressed-air cylinders, so that an extra pressure of air may be turned on when necessary.

VACUUM CLEANERS IN INDUSTRIAL PLANTS

The Vacuum cleaner has been developed with much aggressiveness by its various builders, and has now become of recognized utility in industrial as well as residential life. The modern shop and factory are well ordered institutions, and cleanliness is a prime requisite. The vacuum cleaner is a most complete remover of dust and dirt and finer debris of all sorts. The vacuum system of cleaning promises exceptional usefulness in ridding works of those kinds of dust which are injurious to the health of employees. The manufacturers believe that they can be of great service to factories which do wet grinding, by collecting the dried sediment of particles of abrasive and metal. Where an exhaust system is installed, the apparatus is designed to be attached at conveniently spaced stations.. The self-contained unit, with an electric motor attached to the fan, can be employed in any works having electric wiring. The blower and exhaust have a great usefulness, extending over a wide field. The vacuum cleaner is an addition to the scope of effort, which will undoubtedly be adopted quite generally in the next few years.—*Iron Age.*

A TUNNEL TO SAVE A COAL MINE

Several years ago the Mohawk Coal Company opened a drift at Phillipsburg, Pa., and made preparations to mine coal on an extensive scale. The vein tapped was the *B* vein, the most profitable in the bituminous region, but after great expenditure, mostly in preparation, the drift ran into a peculiar dip in the vein, and the water poured in so that the mine was abandoned. It is reported that the mine has lately become the property of the Lehigh Coal Company, and that the mine is now to be worked. Instead of going to work in the old drift the company is preparing to drive a tunnel through the mountain, and at a lower level, so that the water will flow away by gravity. The coal is of superior quality, and runs four feet in thickness without any "fault" streak.

NOTES

The New York office of the Sullivan Machinery Company has been removed from 42 Broadway to 30 Church street, Hudson Terminal.

A South Yorkshire colliery in 1909 drew out of one shaft 4,500 tons in one day, close on 24,000 tons in one week and considerably over 1,000,000 tons in the year, which is thought to be the record in coal mining.

Don't carry powder about your person to soften it, or attempt to thaw it in the flame of a candle, or crimp a cap with your teeth, or "break" a stick in two. Cut it, no matter how dull your knife is, and if you haven't a knife, go and get one.—*Idaho State Mining Report.*

Municipal water works in many cases present excellent opportunities for power development at slight cost. It has been estimated roughly that 50,000 h. p. can be developed on the line of the Los Angeles aqueduct within easy transmission distance of the city, and recently a commission of three specialists has been appointed to make an exhaustive study of the possibilities.

After half a century of development flowing oil wells or "gushers" are still occasionally found in Pennsylvania, a 7,000 barrel well having been brought in quite recently at Shumiston, the first of this size in this field in ten years. The high grade of Eastern oil makes such a strike important.

In a deep Belgian coal mine, at the 3,300 ft. level, cow bells are hung from chains strung across the gangway near the escape shaft. These are so placed that in case of an outburst of gas which might put out the safety lamps the miners would be guided by the bells to the shaft and safety.

A recent washout on the San Pedro, Los Angeles & Salt Lake R. R. took out substantially all the track on the main line between Acorna, Nev., and Rox, about 90 miles. A locating party is already in the field for a new line, the building of which will take six months or a year.

An edict has been issued by Gen. Estrada permitting the free entry of mining machinery and materials for the mining industry of every character. Since the entire east coast of Nicaragua is under Estrada rule and the exempted articles are, in the main, imported along this coast, the order is tantamount to a government ruling.

It has been planned to run a tunnel about 12 miles long at Pachuca, Mexico, starting at a depth of 1,000 feet below the lowest level of any of the mines and to cut them at that depth, or about 3,000 feet below the surface. The main veins to be tapped would be the Santa Gertrude's, the Real del Monte, and the Bar ron.

A valuable by-product is obtained in making chromium by the Thermit process. This by-product has been named corubin and it is claimed to be one of the best abrasive materials obtainable. It is used extensively abroad in the manufacture of high grade emery wheels and emery cloth and for other purposes where a first class abrasive is required.

The 4,725 tons of coal burned by the Lusitania on a record trip across the Atlantic would be fuel enough to keep ten families warm for a generation or more, say a ton a month to each family for 40 years.

At Pierre, South Dakota, on the grounds of the state capitol, there is now an artesian well discharging water at the rate of 5 cubic feet per second and with a pressure at the surface of 165 pounds per square inch.. Mingled with the water is a large volume of natural gas, and it is proposed to use both the water pressure and the gas for light, heat and power purposes. Inquiries are out as to the best means of utilization.

An explosion of a can of asphalt paint occurred recently at a pumping station in Chicago. The can had been placed in a small brick locker room by one of the engineers, and when the explosion occurred the engineer and a coal passer were in the locker. They emerged enveloped in flames. The can showed signs of an internal explosion, the top being partly blown off and the body distorted. Indications are that an explosive fluid had been mixed with the paint to soften it.

The explosion of a tire is the signal for every one to express the most ghoulish glee. No one knows the chauffeur, no one knows the people in the car, there is no personal grudge or apparently any connection between any passerby and the tire in question; but the air is filled with sardonic "Ha's" and every one is overjoyed in obedience to some cruel law which rules some things. One explosion will cheer people as far as the sound carries. It is a deplorable disclosure.—*The Woman Who Saw.*

The German Aerial Navigation Company, of Frankfort-on-Main, has established the first permanent airship lines in Germany. It is the purpose of the company at the start to connect fully 30 cities. It has already received patents for its turn halls for motor balloons, and it will erect the first halls in Berlin, Munich and Strassburg in Alsace. The extensive plans of the company have aroused the liveliest interest on all sides, and their execution appears to be financially assured.

Fertitlizer formulas comprise three figures, as 4-8-10, and these always refer in the same order to nitrogen, available phosphoric acid and potash, respectively. These figures multiplied by 20 will give the number of pounds of each kind of plant food contained in a ton of the mixture. Thus, in a 4-8-10 fertilizer there are 4×20=80 pounds of nitrogen, 8×20 =160 pounds of phosphoric acid, and 10×20 =200 pounds of potash.

The Shoshone dam, the highest in the world, built by the reclamation service, is completed. It is in the canon of the Shoshone river in northern Wyoming, and is 328 ft. high. The walls of the canon are nearly vertical and rise nearly 2,000 ft. above the stream. At its base the thickness of the dam is 108 ft., and its length, the width of the gorge, is 70 ft., and at the top its length is 175 ft. The dam creates an enormous reservoir with a surface area of 10 miles, and with a storage depth of 70 ft. its capacity is 148,500,000,000 gallons.

According to recent consular reports, the European governments have available for service 32 dirigibles and 56 aeroplanes, as follows:

Germany, 14 dirigibles of six different models, Gross, Zeppelin, Parseval, Schutte, Siemens—Schuckert and the Rhine-Westphalian air ship, and five aeroplanes; France, seven dirigibles and 29 aeroplanes; Italy, three dirigibles and seven aeroplanes; Russia, three dirigibles and seven aeroplanes; Austria, two dirigibles and four aeroplanes; England, two dirigibles and two aeroplanes; Spain, one dirigible and three aeroplanes.

The advantage of mounting a machine drill on a cross-bar instead of on a vertical post, is that, in driving, the machine can be set up and started running while the muckers are taking care of the rock shot down with the last round of holes. If a post were used, it would be necessary to muck out at the foot of the post, clear down to the floor, before the machine could be securely placed in position. When drilling on a bar, the back and breast holes are put in first, and by the time the machine has to be swung under the bar for the lifters, the rock underfoot has all been removed.

The French call the power derived from waterfalls *houille blanche*—"white coal"—and a singular combination of the power derived from white and from black has recently been effected at Etupes, in Eastern France. At that point electric conductors coming from the coal mines of Ronchamp, 18 miles north of Etupes, meet similar conductors coming from the waterfalls of Le Refrain, 24 miles south of Etupes. The current derived from the mines is of 30,000 volts and that from the waterfalls of from 30,000 to 50,000 volts. At Etupes the power is combined in a large plant, provided with transformers and distributors, and sent out to run shops, light lamps, and so forth.

Under the direction of Mr. Edward O'Toole, General Superintendent, the U. S. Coal and Coke Company, at Gary, W. Va., is laying down a 24-inch experimental pipe for testing the practicability and the economy of pneumatic transportation as already employed for grain, sawdust, ashes, etc. The deterring feature heretofore has been the unwarranted power consumption; it is claimed now, however, that by using a number of vacuum chambers the power required may be greatly reduced, and that by the addition of successive vacuum chambers the distances through which coal can be transported may be indefinitely increased. It is expected that reliable and valuable practical data will be furnished by this installation.

On December 14, 1909, the first shipment on the American continent of calcium cyanamid or lime nitrogen, was made. It comprised 300 bags (26 tons) sent from the plant at Niagara Falls, Canadian side, to the American Cyanamid Company, Baltimore. This company operates a plant at Niagara Falls, using 8,000 horse power and obtaining the nitrogen of its product directly from the atmosphere. The installation is said to already represent an investment of $600,000. It is being built in units of 10,000 tons per annum capacity, but one as yet being in operation. The company operates a plant at Baltimore for reducing and refining its product and putting it into marketable shape to meet the requirements of the various fertilizer manufacturers.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JANUARY 4.

945,048. APPARATUS FOR MAKING OXYGEN. CHARLES RIDLEY, London, England.

945,063. AUTOMATIC AIR-BRAKE. WALTER V. TURNER, Edgewood, Pa.

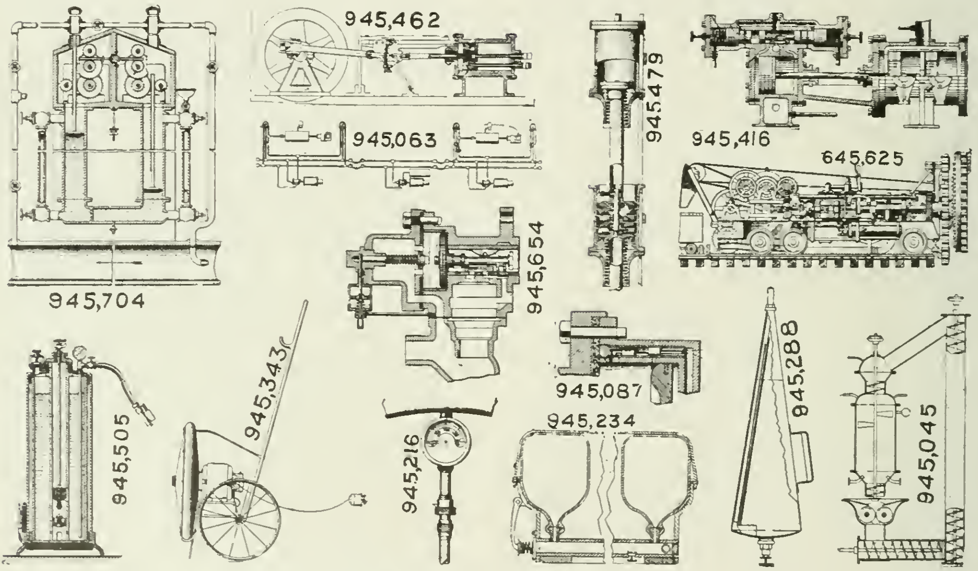
945,087. FLUID - PRESSURE RAILWAY-BRAKE. CHARLES G. FREY, Youngwood, Pa.

945,209. ROCK-DRILL. ADDISON AVERY, Chicago, Ill.

945,216. AIR-PRESSURE INDICATOR. HENRY W. BROWN and GARRETT H. BROWN, Syracuse, N. Y.

945,234. PNEUMATIC MATTRESS. NEHEMIAH C. HINSDALE, Marion, Ind.

945,288. PRESSURE-COMPENSATING DEVICE FOR THE AIR INCLOSED IN FIRE-EXTINGUISHING APPARATUS. KARL SCHMIDT, Neuruppin, Germany.



PNEUMATIC PATENTS JANUANY 4.

945,343. VACUUM CLEANING APPARATUS. CHARLES R. POLLARD, Hartford, Conn.

945,416. AIR-SWITCH. CHARLES F. PRESLAR, Cincinnati, Ohio.

945,462. FLUID-PRESSURE ENGINE. JACOB P. KLEIN and ADOLF FRIEDERICHS, San Bernardino, Cal.

945,479. MACHINE FOR FORMING CUP-LEATHERS. WAYLAND F. SMITH, San Bernardino, Cal.

945,505. APPARATUS FOR REMOVING PAINT AND VARNISH. CHARLES J. FESS, Newark, N. J.

5. An apparatus for heating and spraying varnish remover comprising an inclosed cylinder, an air-pump associated therewith, a removable receptacle adapted to surround the cylinder and to form an air-space about the sides of the cylinder, a rheostat in the receptacle, a high resistance element, and a manually operated switch arranged to connect the rheostat directly across the mains from a suitable source of electrical supply, or to connect the rheostat and a high resistance element in series across said mains.

945,623. TUNNELING-MACHINE. LOUIS F. SLEADE, Denver, Colo.

945,654. AUTOMATIC TRIPLE VALVE FOR AIR-BRAKES. ALBERT V. WESTER, Gallitzin, Pa.

945,704. GAGE FOR DETERMINING THE VELOCITY OF FLUIDS. FRANCIS H. CRAWFORD and MICHAEL B. CARMODY, Columbus, Ohio.

JANUARY 11.

945,758. AIR-BRAKE APPARATUS. NATHAN H. DAVIS, Philadelphia, Pa.

945,815. PNEUMATIC TOOL. HERMAN SCHWEIM, Detroit, Mich.

945,884. VALVE FOR PNEUMATICALLY-CONTROLLED MUSICAL INSTRUMENTS. PETER WELIN, Newcastle, Ind.

945,988. AIR-COMPRESSOR. CHARLES G. SIMONDS, Schenectady, N. Y.

945,998. APPARATUS FOR SUBMARINE SIGNALING. EDWARD C. WOOD, Somerville, and HARRY G. MARDEN, Braintree, Mass.

1. A means for operating the striking means of a submarine signaling apparatus having a sounder and a striking means comprising a cylinder, a differential piston moving therein and connected with said striking means and a compressed air reservoir permanently connected with the smaller side of said piston, and intermittently connected with the larger side thereof, in combination with a casing containing said cylinder and said reservoir, as described.

946,025. FLEXIBLE PIPE-JOINT. ALBERT G. ELVIN, Franklin, Pa.

946,069. APPARATUS FOR DRYING AIR. IRVING H. REYNOLDS and FRED E. NORTON, Youngstown, Ohio.

946,101. INFLATING-PUMP FOR MOTOR-VEHICLE TIRES. MAX BOHNE, Berlin, Germany.

946,307. TANK FOR ADMINISTERING OXYGEN. GEORGE VON ACH, Newark, N. J.

946,368. PNEUMATIC HAMMER. CHARLES L. JONES, Urbana, Ill.

946,420. ROCK-DRILL. RALPH F. YOURTEE and WILLIAM E. MAULL, St. Louis, Mo.

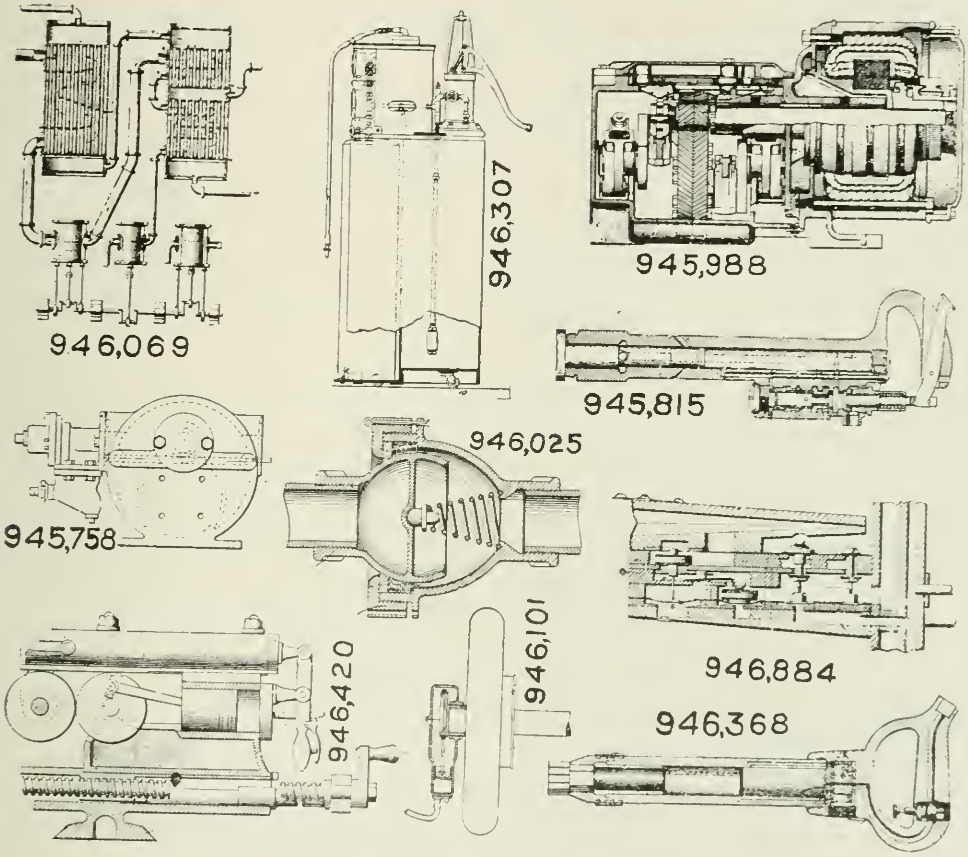
JANUARY 18.

946,535. SEPARATOR FOR PNEUMATIC CLEANERS. FRANK B. CRAVER, Rochester, N. Y.

946,678. AIR-SHIP AND AEROPLANE. EDWIN J. LESTER and WILLIAM G. BEST, Clapham, England.

946,683. HYDRAULIC AIR - COMPRESSOR. JOHN W. NEAL, Kealia, Hawaii.

946,684. BACK-PRESSURE VALVE. CHARLES C. NEIGHBORS, San Antonio, Tex.



PNEUMATIC PATENTS JANUARY 11.

946,719. AIR-PUMP. FRED S. CARVER, Brooklyn, N. Y.

946,801. VACUUM-CLEANER. ROBERT B. HUTCHISON, Wilkinsburg, Pa.

946,832. VACUUM CLEANING DEVICE. JOHN N. WHITEHOUSE, New York, N. Y.

946,843. DRYING APPARATUS. DANIEL HURLEY, Providence, R. I., and JOHN E. O'SHEA, New York, N. Y.

946,889. HEATING, COOLING, AND VENTILATING SYSTEM. JULES C. VEIL, New York, N. Y.

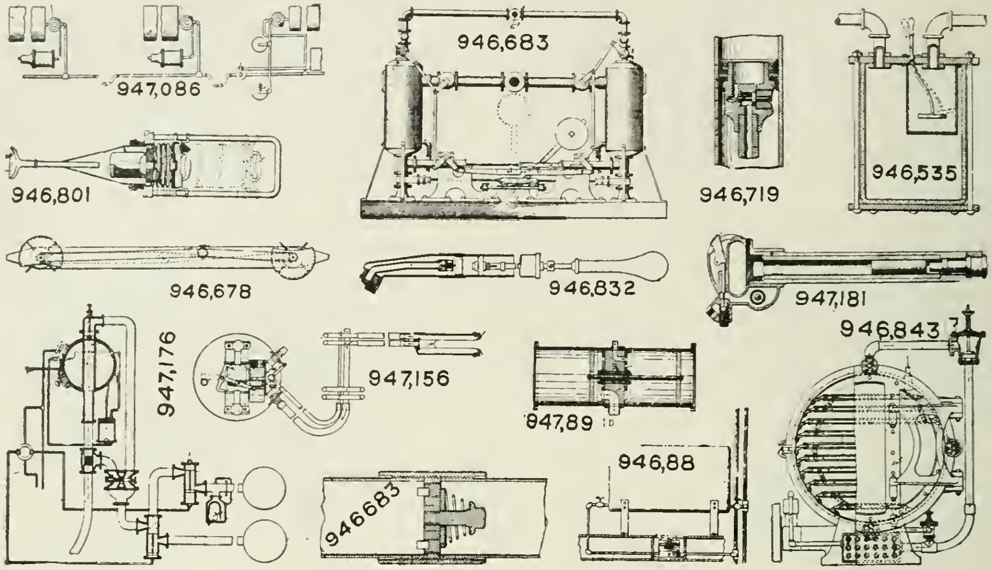
947,040. HUMIDIFIER. JAMES KELLY, Providence, R. I.

1. In a humidifier for discharging mingled water and air under pressure, the combination of a nozzle having a plurality of tubular passages extending longitudinally through said nozzle and parallel with each other, each of which passages has a closed bottom and is provided with a radially directed discharging orifice; a deflecting device mounted in the upper end of said nozzle centrally between said tubular passages; and an annular flange mounted on the nozzle at or adjacent to all said discharging orifices and approximately in the plane thereof, and provided with a concaved upper surface; all arranged so that the current of said mingled water and air is divided and separated by the deflecting device and directed thereby through the tubular passages in separate currents, which are discharged therefrom upon the concaved surface of the annular flange.

947,086. FLUID - PRESSURE AIR - BRAKE MEANS. GEORGE T. ROWTON, Jackson, Miss.

947,156. PNEUMATIC MILKING APPARATUS. ALEXANDER GILLIES, Heidelberg, Victoria, Australia.

947,176. PNEUMATIC APPARATUS. EMMANUEL L. J. GISSOT, Vanves, France.



Pneumatic Patents January 18

947,181. FLUID - PRESSURE - OPERATED TOOL. Charles H. Johnson, Springfield, Ill.

947,189. VACUUM AND FLUSHING APPARATUS. David Roderick, San Diego, Cal.

JANUARY 25.

947,300. HUMIDIFIER. John W. Fries, Winston Salem, N. C.

947,301. HUMIDIFIER. John W. Fries, Winston Salem, N. C.

947,333. VENTILATION AND AERATION OF SEWAGE IN SEWAGE PLANTS. Frank Hamilton, Jamaica, N. Y.

947,385. DEVICE FOR PREVENTING WRECKS UPON RAILWAYS. John G. Henzel, Chicago, Ill.

947,513. TIRE-PUMP. William S. Stapley, Bridgeport, Conn.

947,533. PUMP DRIVEN BY MEANS OF COMPRESSED OR RAREFIED GAS. Olof Rodhe, Stocksund, Sweden.

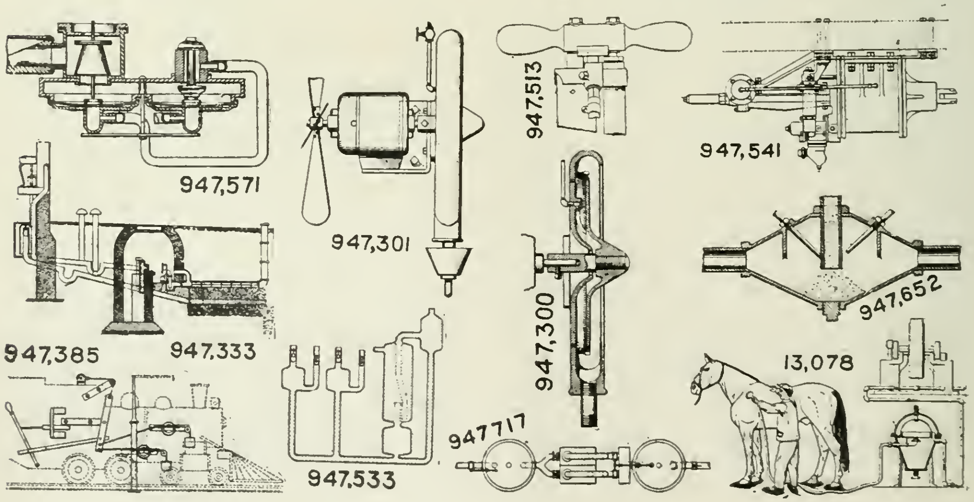
947,541. AIR-BRAKE-CYLINDER ATTACHMENT. Christopher P. Cass, Maplewood, and Henry A. Wahlert, St. Louis, Mo.

947,652. TRACK-SANDING APPLIANCE. Fred G. Schwartz, Colorado City, Colo.

947,688. PNEUMATICALLY-OPERATED TYPE-WRITING MACHINE. Max Soblik, Dusseldorf, Germany.

947,717. APPARATUS FOR THE PRODUCTION OF CARBURETED AIR. Mortimer F. Mieville, Chichester, England.

13,078. ANIMAL-CLEANING APPARATUS. Conrad Hammer, Buffalo, N. Y. (Reissue).



Pneumatic Patents January 25.

COMPRESSED AIR MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV APRIL, 1910 No. 4

AN ELECTRIC-AIR MARBLE QUARRY

The half tone here presented gives us a realistic view of what we may well characterize as the most up-to-date quarry in the world. It is that of the Dover White Marble Company, at South Dover, N. Y., near Wingdale, on the Harlem Division of the New York Central Railroad. This is a quarry of pure white marble which borings show to be of great depth and of uniform excellence of quality, and which at the surface is favorably situated for convenient and economical working. Being on the side of a hill there is no cost for drainage, and the use of a gas producer plant and gas engine direct connected to an electric generator brings the coal cost of the current which operates the entire plant down to but little over three-tenths of a cent per electric horsepower hour.

The employment of electricity as the mo-

QUARRY OF DOVER WHITE MARBLE COMPANY.

tive force for the entire plant is made possible by the use of Electric Air channelers and gadders, which do the responsible work of cutting out the dimensioned blocks of stone with phenomenal facility and economy. Channelers and gadders have heretofore been driven either by steam or by air, but they are here operated by the Electric Air arrangement with all the facility and effectiveness of the older devices and at only a fraction of the cost.

The fireproof power house of the quarry, which has been built with provision for a larger installation later, contains an automatic suction gas producer plant which supplies a double acting Riverside gas engine directly connected to an electric generator which supplies current for all the motors and for an ample storage battery equipment used for lighting the quarry and buildings. As the equipment was to supply both light and power, and on account of the relatively small proportion of the current used for lighting, a 250 volt, direct current type of machine was selected. The current here generated is conveyed by overhead wires wherever required in the quarry.

The entire quarry as at present operated is served by a radial cable-way, the fixed or pivot tower being located at the foot of the hill and the moving tower at the higest level of the quarry. This traveling head moves on an arc five hundred feet long, being moved by electric motor as required, the same wiring serving also for the hoist and for the cable traveler. This cable-way has a lifting and conveying capacity up to 40 tons.

In the quarry proper are five Electric Air track channelers and five Electric Air gadders, all taking current from overhead trolley wires. In the half tone one of the channelers is seen in the back ground at the extreme left in front of the movable cable tower and another channeler is seen more closely nearer the front of the view, while a gadder is shown at the right of the picture.

A gadder, it is well understood, is simply a mounting for any suitable rock drill which facilitates the precise locating and the rapid drilling of lines of holes at any required angle from the horizontal to the vertical. In this case each gadder carries a regular Electric Air drill, the piston of which is reciprocated, as in all cases in this type of drill, by alternating pulsations of air in each end of the cylinder, the pulsations being produced by the electric driven apparatus which accompanies and is in fact a part of the drill. As shown in the half tone, the little pulsator truck is at the right of the gadder itself with the operator standing between. The two short lines of hose connecting the pulsator and drill are easily distinguished.

The channeler, the piston of which carries the entire set of channeling steels, going to working depths of five or six feet, of course has a cylinder of considerably larger diameter than the gadder drill, but otherwise is operated upon the same principle. The pair of pulsators and their occompanying motor are in this case mounted upon the machine frame, and the channeler is thus entirely self-contained.

These machines and the entire plant are working together most satisfactorily and with high efficiency. It is not necessary to call attention to the great saving of power by the use of the Electric Air arrangement as compared with the direct employment of either compressed air or steam, as this is now far beyond all controversy. This quarry will, of course, present a much neater and a more business-like appearance, and will be more interesting in every way, after a considerable quantity of stone shall have been taken out, of which there is now every assurance.

DRINKING DEW

At the fortification of Gibraltar fresh water is very scarce and the following arrangement has been adopted to eke out the supply for the use of the garrison. A large pit is dug in the earth and covered with dry wood or straw, which in turn is covered either with earth or with sheet iron. The straw or wood serves as a heat insulator and prevents the conduction of heat from the ground to the outer covering of earth or sheet iron. This earth or iron covering then cools after sunset more rapidly than the ground, so that the temperature soon falls below the dew point of the surrounding air. Dew is then formed upon the iron or the layer of earth in large quantities and the water thus obtained is drained into reservoirs where it is clarified and is then used for drinking.

HIGH PRESSURE PORTABLE ILLUMINATING GAS

It has been experimentally demonstrated that dry Pintsch gas is suitable for transportation under a pressure of 100 atmospheres or over.

For this purpose Pintsch gas, from which all liquid hydro-carbons have been removed while under the pressure of 14 atms., is used, and the dry gas is compressed directly into steel flasks at high pressure. Under this high pressure a partial condensation of the gas takes place, which, however, disappears as soon as the pressure is reduced, the gas presenting again its original dryness and other characteristics with but an inappreciable loss in candle power.

A steel flask of 3.75 cu. ft. capacity and weighing about 330 lbs. will, when charged to a pressure of 100 atms., yield about 500 cu. ft. of gas at atmospheric pressure. From this it is seen that the gas under these high pressures deviates considerably from Boyle's Law, in accordance with which the flask would be expected to yield but 375 cu. ft. of gas at atmospheric pressure. The deviation from Boyle's Law at a pressure of 100 atms. amounts to about 33 per cent. increase. This departure, combined with the fact that small seamless flasks can be made of steel of high tensile strength, render it possible to reduce the weight of the transport holder for a given quantity of gas carried, by over 50 per cent. The space occupied by the high-pressure holders is only about one-tenth of that of the holders used in transporting gas at a pressure of 14 atms.

The true value of the high-pressure transportation becomes, however, most apparent in cases where no compressing facilities are available, at the point of distribution, to transfer the gas from the transport holder to buoys or cars, where filling can only be accomplished by equalizing the pressure. In such cases but about 30 per cent. of the gas carried in holders at a pressure of 14 atms. is available for filling, and the remainder of the gas returns to the supply station unused. In the case of high-pressure transportation, however, fully 90 per cent. of the gas transported becomes available for filling, and under these circumstances the weight of the transport holders for a given quantity of gas filled to buoys or cars is only about one-sixth and the volume only about one-thirtieth of that of the transport holders used by the former method.

COST OF DRIVING ENGINES BY COMPRESSED AIR

It is often in practice desirable to know the amount of compressed air—generally measured as free air, however—necessary to operate engines of given size, and the economy that can be obtained thereby, or, in other words, the amount of fuel to be consumed to drive a steam actuated air compressor to develop a given horse power in the engines which are operated by the compressed air. This question is treated in a recent article by Mr. Snowden B. Redfield in the *American Machinist*, an abstract of which is here presented.

Few actual data from experiments are available on these subjects, but the results shown by the accompanying diagrams give much information which should be of value in this connection. These results have been figured not only for theoretical conditions, but also for, what is more important, practical conditions as well. The curves plotted from these figures will give the results which should be obtained with perfect apparatus and also with ordinary machinery in commercial use. The theoretical results will be found useful for studying the subject and for the checking up of actual results obtained from the machines themselves. The figures for practical performance are based upon actual conditions of operation such as would be obtained in any well organized plant, taking into consideration every probable defect in the mechanism and operation, which it would not be possible to avoid.

THE PROPOSITION.

It is proposed in the calculations from which the curves are plotted to drive a reciprocating steam engine having a flywheel and valve gear, the latter being capable of suitable adjustment to give the results desired. Compressed air is supposed to be furnished by an ordinary reciprocating compressor of modern design and ordinary performance.

It is well appreciated that to obtain economy in an engine of any sort expansion of the fluid operating in the cylinder is necessary. If expansion in the engine cylinder using air is carried to too great an extent the temperature of the air in the cylinder will fall below 32 degrees Fahrenheit, and consequently the moisture in the air will freeze, this freezing leading to the clogging up of the exhaust ports, the formation of ice over the outside of the cylinder and very probably the stopping of the engine. For this reason it is essential that the temperature of the expanding air does not fall below the freezing point.

In all the calculations connected with this case it is assumed that the terminal temperature of the expanded air in the engine cylinder shall fall to 35 degrees Fahrenheit and no lower. Under this assumption the engine is supposed to be given an earlier and earlier cut-off to give greater and greater economy. Earlier cut-off will, of course, mean greater ratio of expansion, and this in turn means a greater drop in temperature of the air. In order, therefore, to insure that the terminal temperature of the expanded air shall not be lower than 35 degrees, it is assumed that the air entering the engine cylinder is heated to a temperature such that with the given cut-off, the final temperature shall not be below this point.

THE THEORY FIRST.

Glancing at the accompanying chart, in the upper left-hand corner will be found four indicator diagrams. The two upper ones are for strictly theoretical conditions, the left-hand diagram being that of the air cylinder of the compressor and the right-hand diagram that of the working cylinder of the engine driven by the compressed air. The two indicator diagrams below this represent practical conditions, taking into account all the usual losses due to imperfect mechanical devices and faults in operation.

To make the theoretical case simpler it is assumed that the temperature of the atmosphere is 35 degrees. The air at this temperature enters the cylinder of the compressor, and in a single stage is compressed up to 90 pounds gage pressure, when, as shown by the diagram, its temperature will be 415 degrees. This air is then supposed to enter the engine cylinder without any loss of pressure or temperature. If now the valve gear of the engine is set to cut off at just about 0.26 the air in this cylinder will be expanded down to atmospheric pressure and its temperature will have been reduced to 35 degrees. At this temperature and atmospheric pressure it is assumed that the air is exhausted to the atmosphere.

Such an arrangement as this would mean ideal conditions, and the efficiency, calculated from the ratio of the work done in the engine cylinder to that done in the air-compressing cylinder, would be 100 per cent. Furthermore, the mean effective pressure theoretically developed in the engine cylinder would be about 39 pounds and the indicated horsepower developed in the air-compressing cylinder per indicated horsepower developed in the cylinder of the engine using the compressed air would, of course, be 1.

This is the extreme, and only theoretically possible, case. The worst possible case under theoretical conditions would be to assume that after the air has been discharged from the compressing cylinder at 415 degrees and 90 pounds it shall have become entirely cooled while passing through the pipe leading from the compressor to the engine, so that its temperature when reaching the latter is only 35 degrees. The pressure is assumed to remain at 90 pounds. Under these circumstances it is, of course, impossible to allow any expansion of the air, because no drop in temperature is allowable or freezing will take place. The engine must then admit air through the full stroke, when the exhaust valve would open and the air would expand simply into the atmosphere without doing any useful work and without any appreciable temperature drop.

Under these circumstances the indicator diagram would be represented by a rectangle, there being no slanting expansion curve. This would, of course, give very poor economy, because although theoretically 90 pounds mean effective pressure is developed in the engine cylinder, a very large volume of air must be used, to do a given amount of work. To develop 1 indicated horsepower in the engine cylinder, without expansion, the compressor will be called upon to develop about 3.2 horsepower in its air-compressing cylinder, giving a theoretical efficiency of only about 31 per cent.

Between these two cases there is a wide range of possible conditions. In the calculations, therefore, it is assumed that the air coming from the compressor is admitted to the engine cylinder at various temperatures ranging all the way from 35 degrees as a minimum, to 415 degrees as a maximum, and in each case the cutoff is so set that the air in the engine cylinder will expand until, at the end of the stroke, its temperature has dropped to 35 degrees. Such an intermediate indicator diagram is shown by the full lines in the upper left-hand section of the accompanying chart. Such conditions will, of course, give rise to

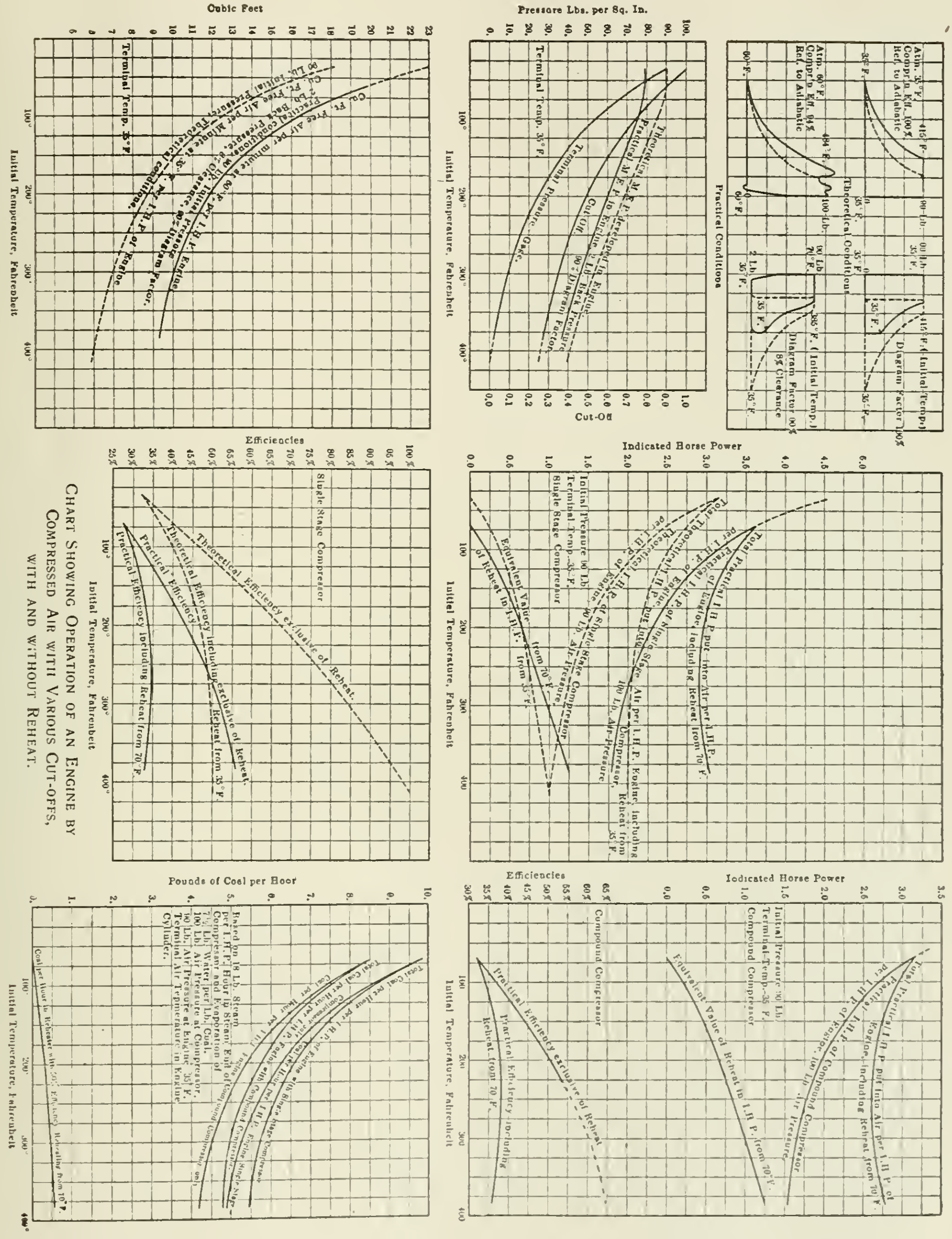


Chart Showing Operation of an Engine by Compressed Air with Various Cut-offs, with and without Reheat.

an economy which is intermediate between that of the perfect theoretical conditions and the most imperfect theoretical conditions, as described.

CUT-OFF, MEAN EFFECTIVE AND TERMINAL PRESSURES.

Looking first at the middle diagram on the left-hand side of the chart, we will see that when the air enters the engine cylinder with an initial temperature of only 35 degrees, the cutoff, as shown by the line so marked, will be unity, that is, there will be no cutoff at all. This, as shown, will result in a mean effective pressure in the engine cylinder of 90 pounds, there being no loss assumed under these theoretical conditions. There being no expansion the terminal pressure will also be 90 pounds as shown by the curve marked "Terminal Pressure."

Following these curves a little further we will find that if the air is admitted to the engine cylinder at 100 degrees it will be possible to so set the engine valves that the cutoff may occur at about 0.75 of the stroke. This will result in a theoretical mean effective pressure developed in the engine cylinder of 85 pounds, and the terminal pressure by the time the temperature has dropped to 35 degrees will be found to be 53 pounds. At 300 degrees, under these theoretical conditions the cutoff may be set at 0.35 stroke. The theoretical mean effective pressure developed in the engine cylinder will then be about 53 pounds and the terminal pressure will have fallen to about 9 pounds, the terminal temperature, of course, being 35 degrees as in every case. If the air is allowed to enter the engine cylinder at 415 degrees, the results will be as already outlined for the most perfect theoretical conditions.

QUANTITY OF AIR REQUIRED.

After this study of the engine indicator diagram we may determine the quantity of free air required per minute to develop 1 indicated horsepower in the engine cylinder, under these same varying conditions. Looking first at the theoretical state of affairs as shown by the dotted curve in the lower left-hand section of the chart we will find that with 35 degrees initial temperature in the engine cylinder it will require a little over 18 cubic feet of free air per minute to develop 1 indicated horsepower. At 300 degrees initial temperature about 7 cubic feet of free air and at 415 degrees about 5.9 cubic feet, will be required per minute to develop 1 indicated horsepower in the engine cylinder. In each case this air is measured at atmospheric pressure and 35 degrees temperature.

REHEATING.

At this point something should be said about reheating, as this is one of the most important points in the use of air in engines having cutoff. So far we have assumed that the air delivered to the engine has simply cooled to a certain point as it passes through the pipe line between the compressor and the engine. Under actual conditions it usually happens that the air has cooled to very nearly atmospheric temperature before reaching the engine, and consequently, in order to obtain economy by the use of cut off in the engine, it is necessary to reheat the air before allowing it to pass into the engine cylinder. This reheating of the air of course means the consumption of additional fuel, but, owing to the nature of compressed air itself, this additional heat put into the air will develop power in the engine cylinder with an economy practically unattainable by any other method of transforming heat energy into motion. By means of separate reheaters, therefore, it is possible not only to use compressed air in an engine where conditions make it desirable to use air instead of steam, but it is also possible to develop power with a very reasonable degree of economy.

When burning coal under a steam boiler an economy of 70 or 75 per cent. is possible and often is attained. With a properly designed reheater for heating the compressed air before entering the engine it is undoubtedly possible to obtain an economy equal to this, but under ordinary working conditions the reheater in an air plant receives but scant attention unless a special man is hired for this purpose. Indeed, considering the neglect which reheaters receive under usual conditions the economy obtained by their use is wonderful. However, not to favor the reheater too much it is assumed in these calculations that the efficiency of the transference of the heat from the coal to the air is only 50 per cent. In other words, only one-half of the heat available in the coal is assumed to have been put into the compressed air in the reheater before actually entering the engine cylinder.

This compares with rather poor steamboiler practice, but at this point the analogy ceases, for with the steam plant, although the steam may contain 70 or 75 per cent. of the heat of the coal, only about 12 or 15 per cent. of this heat is actually transformed into work in the engine cylinder. On the contrary, when using heated air in an engine cylinder the economy of the transformation of the heat in the air into work may well reach 80 per cent.

POWER IN THE REHEATER.

All heat which is put into the air in the reheater must, of course, represent additional energy from the coal pile, just the same as the energy which is put into the air by its compression in the air compressor, and therefore the coal burned in the reheater should be charged against the plant in obtaining the total economy. In the upper central diagram, and also in the upper right-hand diagram showing power curves, will be found curves marked "equivalent value of reheat in indicated horsepower." The dotted curve, representing the theoretical conditions, assumes that the air is reheated from the temperature of the atmosphere, namely 35 degrees, to the various initial temperatures marked underneath the curves. Practical conditions will be described further on.

Examining the upper central diagram it will be found that, for the theoretical conditions as shown by the dotted line, the equivalent value of the reheat is of course zero when the air enters the engine cylinder at 35 degrees, and when the initial temperature is raised to 100 degrees it is seen that the heat in the air is equivalent to about 0.37 indicated horsepower per indicated horsepower developed in the engine cylinder by the hot compressed air.

This increases as the temperature is raised until finally, when the air is reheated to an initial temperature of 415 degrees, corresponding to the temperature at which it left the compressor cylinder, the heat put into the air is equivalent to 1 indicated horsepower per indicated horsepower developed in the engine cylinder.

We have already found that in order to compress the air to 90 pounds pressure and develop 1 indicated horsepower in the engine cylinder under the theoretically perfect conditions, 1 indicated horsepower has also been developed in the compressing cylinder. This goes to show, therefore, that all of the work which is done in the engine cylinder has come from the heat in the air, and as it has been assumed that the compressed air has entirely cooled to 35 degrees and then been reheated by the separately fired reheater to 415 degrees, it is this extra heat put into the air in the reheater which does the work in the engine cylinder. As far as the work done in the compressor is concerned this latter is all thrown away when the air in the pipe line has been allowed to cool down to its original atmospheric temperature. In other words, under these circumstances, the compressor has done 1 indicated horsepower of work, which has then been lost in radiation and the reheater has added another indicated horsepower in the shape of heat, making 2 indicated horsepower expended upon the air to develop 1 indicated horsepower in the engine cylinder. This is a theoretical efficiency of 50 per cent.

EFFICIENCIES.

All of these factors of horsepower developed in the compressor; horsepower put into the air in the reheater, and total indicated horsepower put into the air per indicated horsepower in the engine, will be found in the upper central diagram. In the lower central diagram will be found the corresponding curves for efficiency. Two of these curves are marked "efficiency exclusive of reheat." By this is meant that no reheater is used, but that under the conditions of operation the air from the compressor has simply cooled by radiation in the discharge pipe, from its natural temperature of 415 degrees, to the various initial temperatures shown at the bottom of the diagram, and that the work done has actually come from the compressor only. This work of the compressor is represented by the line in the diagram just above, marked "indicated horsepower of single stage compressor per indicated horsepower of engine," etc. The indicated horsepower of the compressor refers to the air end only, in all cases.

PRACTICAL CONDITIONS.

Looking now at the two indicator diagrams marked "Practical conditions" in the upper left-hand corner of the chart, it will be found that the following practical considerations are assumed: The atmosphere is assumed to be 60 degrees, and the compression efficiency of the air cylinder of the compressor is assumed to be 94 per cent., that is, 6 per cent. loss over and above theoretical adiabatic conditions; 88 per cent. mechanical efficiency of the compressor also is allowed. Further, it is assumed that there is a ten-pound pressure drop in the pipe line from the compressor to the engine, and consequently the compressor must pump the air to 100 pounds pressure, in order to reach the engine at 90 pounds. Also it is assumed that under the worst case of cooling of the air from the compressor, the initial temperature of the air in the engine cylinder is 70 degrees, or 10 degrees above the atmosphere. It is from this temperature that all the reheating is calculated under the practical conditions. Furthermore, the back pressure or exhaust of the engine using the compressed air, is considered to be 2 pounds above the atmosphere.

To allow for the rounding of the corners of the diagram, due to the operation of the valve gear, a diagram factor of 90 per cent. is used; or the mean effective pressure actually developed in the engine will be 90 per cent. of what would theoretically be obtained under the conditions of initial pressure and the given cutoff. As a final practical condition, the engine cylinder is supposed to contain 8 per cent. clearance, this clearance operating to increase the amount of air required. Just as in the theoretical condition, it is likewise assumed that the final temperature of the air after expansion is 35 degrees, or just above freezing. No leakage in the system is taken into account, as it is considered that the pipe lines and connections for a permanent installation would have no more leaks than a similar steam pipe line leading from a boiler to an engine.

PRACTICAL TEMPERATURE RANGE.

Under the best practical conditions, allowing the air in the engine cylinder to expand down to two pounds above atmosphere for the back pressure, the initial temperature in the cylinder can be 385 degrees. With these conditions a cutoff of about 0.27 can be used, resulting in a practical mean effective pressure in the engine cylinder, with all the above enumerated losses taken into account, of about 37 pounds. These conditions are shown by the dotted indicator diagram in the lower set, having these temperatures and pressures marked upon it, in the upper left-hand portion of the chart.

From the chart it will be seen that 385 degrees is the maximum temperature of reheating which is practically considered. Of course it would be perfectly possible to heat this air to a much higher temperature provided lubrication troubles were not encountered, but under these circumstances one of two things would happen. First, if the temperature were greater than 385 degrees, and the expansion were carried out to 35 degrees, the terminal pressure of the air in the cylinder would be below the back pressure; producing a loop in the indicator diagram. If, however, with an initial temperature greater than 385 degrees, the expansion were carried down just to meet the back pressure line without producing either a drop or a loop, the temperature of the air in the cylinder at that point would be considerably above 35 degrees, and consequently we would not have obtained from the air all of the work available in the heat. This, therefore, would result in loss of economy. For these reasons the calculations have been stopped, as shown, with an initial temperature of 385 degrees as a maximum.

Glancing at the full line curves in the lower left-hand diagram of the chart, this curve being marked "cubic feet free air per minute at 60 degrees per indicated horsepower engine, practical conditions, etc.," it will be found that with a minimum initial temperature of 70 degrees, about 20 cubic feet of free air per minute per indicated horsepower developed in the engine will be required. This falls off, as shown by the curve, until, with the most advantageous practical conditions of 385 deg. initial temperature, about 9.3 cubic feet of free air will be required per minute per indicated horsepower of the engine.

POWER REQUIRED.

In the upper central diagram will be found the full line curves of practical conditions, showing the horsepower developed in the compressor, that added in the reheater and the total horsepower put into the air per indicated horsepower developed in the engine cylinder. In the lower central diagram will be found also the full line curves of practical efficiency.

All of the curves so far considered assume the use of a single-stage compressor. Glancing at the upper right-hand set of curves on the chart, there will be found results of practical considerations only, and this time assuming the use of a compound compressor. All of the losses, as already outlined for the practical case, are included.

MAXIMUM POWER ECONOMY.

From the two curves of practical efficiency, including reheat from 70 degrees, this efficiency being from indicated horsepower in the engine cylinder to the indicated horsepower in the compressing cylinder of the compressor, it will be noted that a point of maximum efficiency is reached, and so it would appear that there would be no advantage in reheating the air beyond 275 degrees when using a single stage compressor, or 250 degrees with a compound compressor. The curves show a decrease in efficiency after these temperatures are exceeded. As far as efficiency is concerned, this is true, but this is not the whole story. The efficiency in these particular cases does not mean dollars and cents directly, for, as already pointed out, the heat put into the air in the reheaters is developed into work in the engine cylinder at an extremely economical rate.

In order to understand this, it is necessary to glance at the lower-right-hand set of curves. Here the calculations are referred back to the coal pile, and all the results are strictly practical, the conditions imposed being as shown on this diagram. These conditions assume 18 pounds of steam per indicated horsepower per hour in the steam end of the compressor, and an evaporation of 7½ pounds of water per pound of coal in the boiler, in addition to all the other practical conditions as to compression, expansion, pressures, temperatures and clearance already enumerated.

COAL PILE ECONOMY.

In this set of curves it will be found that there is one marked, "coal per hour per indicated horsepower of the engine, single-stage compressor only," and another one marked, "coal per hour per indicated horsepower of the engine, compound compressor only." These curves do not include the coal put into the reheaters, and may, therefore, be taken as the results, assuming that the air from the compressor has simply cooled down in its passage from the compressor to the engine, to the various initial temperatures as marked at the bottom of the curve. At the extreme bottom of the diagram will be found another curve which is marked, "coal per hour in the reheater with 50 per cent. efficiency, reheating from 70 degrees." As intimated, this curve assumes that only one-half of the heat available in the coal burned in the reheater is actually present in the air after passing to the engine.

All the results in these curves are per indicated horsepower developed in the engine, and it will be found that with 385 degrees initial temperature, the compound compressor will require about 4.2 pounds of coal per hour, and the single-stage compressor will require about 4.9 pounds of coal per hour. However, glancing at the curve for the reheater, it will be found that at 385 degrees only a little over one-half pound of coal per hour is required to heat the air to this temperature. The quantity of coal required in the reheater as given by the lower curve, is added to each of the upper curves marked, for the "compressor only," so as to give the total coal per hour per indicated horsepower of the engine, both with a single-stage and a compound compressor, as shown. This total quantity, it will be seen, varies from 9.8 pounds per hour with no reheat and a single-stage compressor, to 5.4 pounds with reheating to 385 degrees. For the compound compressor this total coal per hour varies from 8.5 pounds to 4.8 pounds per hour per indicated horsepower of the engine, according as the reheat increases and the cutoff shortens, giving greater economy.

It will be noticed from these latter curves that a point of minimum coal used is not quite reached as far as the calculations are carried out. It has already been explained why a higher temperature of reheating has not been figured upon. This then shows that reheating is economical from the dollars and cents point of view, even beyond the point where economy seems to decrease from the strictly B.t.u. point of view. This is due simply to the fact, as already explained, that the B.t.u. put into the air in the reheater are put in at a much cheaper rate than those put into the compressor through the steam cylinders of the latter. As a matter of fact, the trend of the curve for total coal per hour in the compound compressor, including reheat, does appear to reach just about a minimum point between 385 and 400 degrees. This point, therefore, would seem to be the maximum reheat temperature for practical conditions.

A BIG QUARRY BLAST

A blast of memorable magnitude was recently fired at the C. C. Cumbler quarry, near Steelton, Pa. The rock from this quarry is used by the Pennsylvania Steel Company for flux in its blast furnaces, and the stone broken by this single blast will last the company four months. Thirteen 6-inch holes were drilled 125 feet deep, which reached below the ground level at the foot of the cliff. The holes were 25 feet back from the face of the cliff and about 20 feet apart, the line of them thus extending about 250 feet. In each of the holes were put eighteen or nineteen 50 pound cases of the explosive and above this charge, or more than half the depth of the hole, earth was tamped in hard. It was estimated that 70,000 tons of rock were liberated by the blast, and it was broken so small that practically no more powder will be required to reduce it to "one man" size.

HYDRAULIC AIR COMPRESSING SCHEMES

The following is a portion of a paper by George C. McFarlane in *Mining and Scientific Press*, San Francisco. It shows several ways in which water may be employed directly in air compression without the intervention of the usual mechanical devices. Economical employment of the power in sight is of course not to be expected, and when the cost of installation is reckoned with it will be seen that the air is not compressed for nothing in any case.

For mines or prospects that are close to high-line ditches or swift streams, where a fall of several hundred feet can be secured with a mile or two of ditch and flume, the following simple contrivance can be used for direct air-compression. As shown in Fig. 1, a short nozzle is bolted to the pipe-line; this nozzle is plugged with a grooved cast block so as to divide the jet into ten or twelve streams as shown in the enlarged cross-section at the right of the cut. These streams are directed into a throat pipe similar in shape to the casing ot the Venturi meter. Air is sucked in and commingles with the water in the long gently tapering combining nozzle, and passing the throat the stream expands into a length or two of large pipe where the air bubbles separate and pass into the nozzle pipe of the air-receiver.

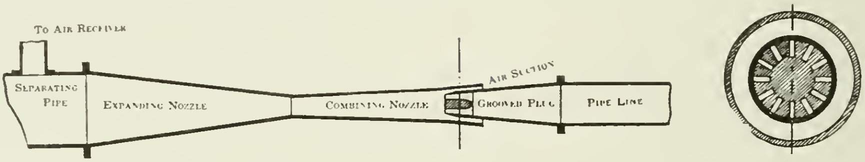


FIG. 1.

Only a portion of the energy of the water can be used in this way. For example, if the pipe-head were 400 ft. and the air pressure used 80 lb., 200 ft. of the head would be expended in compressing the air. After being freed from the entrained air, the water would be under a pressure of 80 lb.; equivalent to nearly 200-ft. head. This could be used to run a water-wheel, or allowed to run to waste. In the latter case the system would be wasteful, but in many cases a cheap, easily installed, plant is preferable to a more expensive one of high theoretical efficiency. To get good results it is important that the lines of nozzle and throat conform closely to those shown in the sketch, the combining nozzle being in length about thirty times the diameter of the small jets. This is long enough to thoroughly mix the air and water. These multi-jets exert a strong suction; 20-lb. pressure will pull a 20-in. vacuum. If the pressure head of the water is 400 ft. and the air pressure 80 lb., 1 ft. of water will compress 1.5 ft. of free air, and the ratio between the area of the issuing jets and the area of the throat should be 1 to 2.1. This scheme may be used to good advantage around placers in case it is desirable to use a couple of small drills for block-holing the big boulders. If there is a good pipe-head, an inch and a quarter bleeder turned into a small jet-compressor would furnish ample air.

In districts where only moderate heads of water are available, and no great expense can be incurred, I suggest a form of direct compressor similar to that shown in Fig. 2, which is practically a highly developed hydraulic ram. To understand the application of the ram or water hammer principle to air-compression, we will suppose a 40-ft. head of water has been flumed to the compressor site and conveyed from the pressure box to the compression chamber by 200 ft. of 2-ft. steel pipe laid on a fairly uniform gradient. We will also assume that the compression chamber holds 60 cu. ft. of free air. The first stage will be to turn the water pressure on the air-chamber, which will fill a little over half full and compress the air to 17.5 lb. Now to compress this air to 80 lb. and force it out of the chamber into the air-receiver will require the expenditure of 285,000 foot-pounds of energy. Our 200-ft. column of water in the pipe weighs 39,000 lb. If this column of water were allowed to fall freely (by suddenly opening the full cross-section of the lower end of the pipe) for a vertical distance of 7.2 ft., or 36 ft. on the slope of the pipe, it would, neglecting pipe friction, acquire a velocity of 21.9 ft., and a kinetic energy of 285,000 foot-pounds. If this were suddenly deflected into the compression chamber it would just have energy enough to ram the air to 80 lb. and drive it out of the chamber at that pressure. It is evident that the lower 36 ft. of water would have gone to waste without accomplishing any work. This means a loss of 18 per cent. The friction would take another 10 per cent, and if we assume fibre stresses of 10,000 lb. per inch in the metal of the pipe-line at 80 lb., the volumetric expansion of pipe-line and chamber under the ramming stress would amount to ¼ cu. ft.; occasioning a further loss of 1 per cent. This leaves the net theoretical efficiency about 70 per cent. From the above it is apparent that the longer the ramming stroke the greater the loss both from waste water and pipe friction. If, however, the air were rammed in the chamber in three or four stages, the theoretical loss would be reduced from 30 to less than 10 per cent.

To accomplish this latter is the idea of the design shown. The penstock pipe curves upward and delivers the water to the compression chamber through an enlarged orifice, the throat of which is opened and closed by a plug controlled by a hydraulic cylinder over the chamber. The pulsations in the pipe-line are caused by a large annular exhaust valve the full size of the chamber. The exhaust valve rests in an annular casing surrounding the inflow and is opened and closed by a piston valve actuated as shown by a small water-motor. For the case cited above, the piston valve would pulsate about fifty beats per minute and four pulsations would fill the chamber. To prevent the water kicking back out of the compression chamber during the overflow cycle, a diaphragm with down closing wing-valves hangs on a shoulder of the piston rod.

The operation of the compressor is as follows: The small water motor pulsates the piston valve at any desired rate, the rocker-arm raising it and the dash-pot snapping it back. When water is turned in the main pipe line, it rushes into the lower port of the hydraulic cylinder, which raises the plug and diaphragm. The water now makes three pulsations, the third bringing the water surface in the chamber to the upper float, opening the auxiliary air line. Depending on the height of the water surface, the opening of the small port of the float valve is much or little. In the former case the piston valve gets a quick cut-off and the final pulsation is short. If the pulsations were not sub-divided into stages and the last one approximately regulated to the work it has to accomplish, the unbalanced water hammer would severely strain the machine. Coincident with the last pulsation the auxiliary air line also shifts the top valves, reversing the hydraulic cylinder, lowering plug and diaphragm, and at the same time the exhaust valve opens wide, permitting the water in the chamber quickly to escape. The receding water level throws the lower float and releases the air from the auxiliary line, throwing the upper cylinder valves and starting a new cycle. A check in the right hand cylinder feed-pipe holds the piston and diaphragm in position during the pulsations of the compression cycle. The compressor is shown on a concrete foundation. A light foundation will answer the purpose equally well. It is only necessary to pack the piston of the hydraulic cylinder and use a wood or leather bearing-ring for the diaphragm. The exhaust and piston valve only need to be machined to a reasonably close fit in their casing. The leakage through them, compared to the large volume handled, would be unimportant and any larger diameter. Assuming the head of water

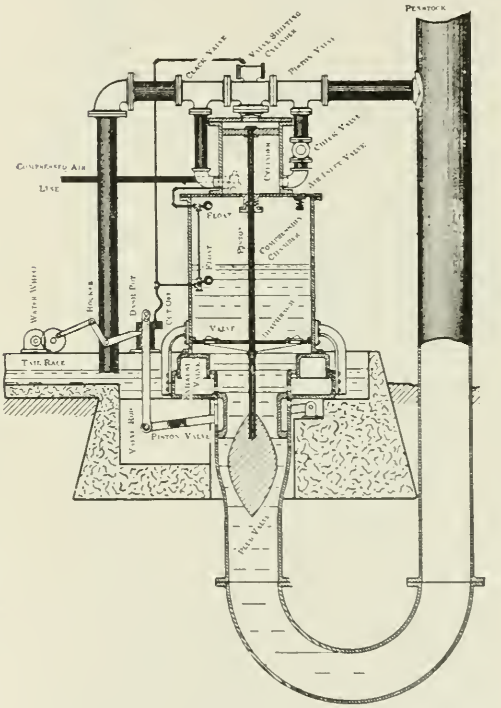


FIG. 2.

scheme of packing rings would impede their free action and increase the expense and difficulty of construction.

For utilizing high heads of water a direct-acting compressor similar to the one shown in Fig. 3, may be employed. This involves practically the same principles as the preceding one. As a pressure of 500 or 600 ft. of water would be too much to turn against the air, a hydraulic plunger is direct-connected to a piston of an air chamber of considerably at 300 feet. and the plunger 18 in., and the air piston 36 in. diam., if the water were admitted slowly to the plunger, 33 lb. of air at 0.7 stroke would balance the water pressure. If the full pipe head were thrown on suddenly, the unbalanced pressure of the air in the first stages would allow the column of water in the pipe to acquire velocity head, which would carry the air pressure up to 70 lb. at 0.8 stroke, allowing a good margin for friction and other losses. In the design shown, the last 0.2 of the stroke of the air piston would be completed by three or four quick pulsations of overflow and water hammer. The arrangement is such that two rotary gate-valves, opened and closed by air pressure, alternately admit and release the pressure on the plunger. When the pressure is turned on, the plunger is shoved upward over three-quarters stroke, the water meanwhile flowing in the take-up cylinder. The air pressure gained is held by the ball check-valve in the take-up cylinder feed-pipe. At this juncture the air pressure is sufficient to crowd out the valve-stem dog and engage the rocker-arm oscillated by the water motor, tripping the lower piston valve overflow, and causing three or four pulsations of water-hammer to completely expel the air into the air-line and receiver. At the end of the stroke the piston trips the tappet in the auxiliary air-line, causing the main valve to close. The exhaust then opens. As the exhaust gate opens, it unseats the ball valve in the cylinder feed-pipe, allowing the plunger to sink, and the displaced water siphons into the tail race. The length of the last pulsation at the end of the compressing stroke is modified by the space to be traversed by the piston. If only a short distance, the needle tappet is raised higher, and a quick cut off is given to the piston valve. The pistons in the air chamber and take-up cylinder would need to have metal packing rings, as they must be tight. The plunger would only need to be a machined fit, as the leakage would spray the sides of the compression chamber and keep it reasonably cool. This latter design of machine would not furnish as good air as the preceding designs, because the air chamber would have to be lubricated and the air, not being in direct contact with the water, would be more or less heated and saturated with oil.

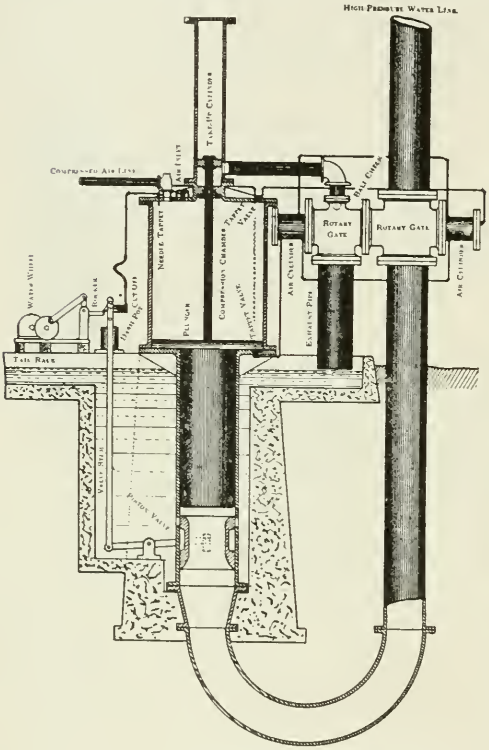


FIG. 3.

NOTES ON THE POHLE AIR LIFT

By W. S. Anderson.

The proportions of piping, submergence, etc., in the Pohle air lift may be arrived at mathematically, basing the calculations on the expansion of the air bubbles as they rise to the discharge where the head due to the sum of the water pistons above diminishes, and on the usual formulas covering capacities of air and water pipes; but for practical purposes in the case of small wells reliable results may be arrived at from the following:

It is found in practice that the length of pipe submerged below the normal pumping level after the water has fallen should range from 30 to 60 per cent. of the total length of pipe from the bottom end to the top of discharge, the latter ratio of 60 per cent. generally giving the greatest efficiency. The air pressure should vary from three-quarters of the pressure due to the total lift for shallow wells to six-tenths for deep wells. It should be such that it will about equal atmospheric pressure at the point of discharge, unless high velocity is desired at the expense of economy. That is, it should equal the head in feet multiplied by 0.434 plus a few pounds for friction, this latter depending on the length of pipe and friction head. In this connection it should be remembered that where a central air pipe is used in drilled wells, on account of there not being room for the air pipe outside of the water pipe, the friction head is greater. If the compressor is close to the well, the reservoir should be proportioned to reduce all impulses, though in the case of a long air line this will to a great extent take care of itself.

In the case of a large well casing, where the inflow into the well is small, or where the desired amount of water is small in proportion to the capacity of the pipe, the air pipe, if central, should purposely be made large enough to prevent blowing, the most desirable proportion, as indicated by practice, being about 1.2 for small wells and 1.3 where the diameter of water pipe is over 2½ in.; or the area of the water pipe is about six times the area of the air pipe for average cases. If the air is taken from shop air mains, where variable service causes a large variation in air pressure, and the air is not run through a reducing valve, the sudden expansion of high-pressure air at the discharge is likely to cause trouble, if the discharge is into a covered or practically closed tank. This may be relieved by putting a large-sized safety valve at any convenient bend.

Assuming 60 per cent. submergence, the volume of free air for maximum economy may be roughly taken from the following: For lifts of 25 ft., 13 cu. ft. of air for 100 gal. of water; for lifts of 75 ft., 28 cu. ft. of air per 100 gal. of water; for lifts of 100 ft., 36 cu. ft. of air per 100 gal. of water; for lifts of 150 ft., 57 cu. ft. of air per 100 gal. of water; for lifts of 200 ft., 75 cu. ft. of air per 100 gal. of water.

With side inlets and ¾-in. air pipes and 1½-in. water pipe, the ordinary capacity will be about 25 gal. per min., and for larger wells the capacity may be assumed as varying nearly but not quite with the square of the diameter of the water pipe. For example, a 6-in. water pipe will ordinarily give a flow at fair economy of from 400 to 425 gal. per min. In the case of central air pipe with 3½-in. casing, the output should be about 110 gal. per min., or 230 gal. with 5-in. pipe, and other sizes in proportion. Generally speaking, from 10 to 14 gal. per sq. in. of area of water pipe, after deducting the air-pipe area, will be about right, the smaller figure being used for short lifts and the larger figure for lifts of 100 ft. or over.

The matter of economy is generally misunderstood and most of the claims of high efficiency should be taken with rather a liberal allowance. While under favorable conditions it may be possible to approach 70 or 80 per cent. efficiency figured from the discharge back to the indicated horse-power of the compressor, most of the tests of ordinary wells where extreme submergence is not possible seem to indicate efficiencies between 20 and 35 per cent. It should also be understood and remembered that the air lift is not well adapted to forcing water horizontally, and horizontal discharges of over 40 or 50 ft. should be avoided, except by discharging into a tank with a gravity flow the rest of the distance.—*Power and the Engineer.*

COST OF HYDRAULIC AIR COMPRESSION

The Taylor system of air compression, adapted to the development of waterfalls of moderate height and copious volume, has elicited much favorable comment, and where it has been installed it has been completely successful so far as the actual compressing of the air is concerned, but the cost which seems inevitable in its installation is not so familiarly known. The following account of one plant is given by Mr. Geo. C. McFarlane in *Mining and Scientific Press* (San Francisco).

"The most recent installation is a 5,000 h. p. plant now about completed at the ragged chutes of the Montreal river, nine miles south of Cobalt, Ontario. Work has been in progress on this installation for three years and for the past year a force of 200 or 300 men has been employed. The Montreal river has here, in about 1,000 ft. a drop of 28 ft. The power people built a concrete jetty into the middle of the river and, to protect the opposite bank from cutting, built a concrete wall in a trench a few feet back and parallel with the bank. During the high water this summer (1909) the river current, thrown sideways by the jettly, gouged into the opposite bank as far as the concrete wall and partly undermined it, which illustrates one way of how not to attempt to raise the level of a swift river.

"Just below the jetty, at the head of the rapids, are two shafts, steel-lined, 16 ft. in diameter and 360 ft. deep. A 20 by 26 ft. tunnel, 1,000 ft. long, connects these shafts with the uprise shaft at the foot of the rapids. The air is compressed to 140 lb. and is conducted to Cobalt by a 20 in. pipe. The pipe was made in 40 ft. lengths, with welded flanges and sliding expansion joints set in concrete pits every half mile. Aside from the transmission pipe lines I would estimate the cost of the plant at the chutes as not far from $1,000,000. This makes the cost per horsepower for installation about $200, which does not compare favorably with the cost of an ordinary air plant. I know of two small plants that were installed for less than $90 per horsepower, including flume and pipe line, as well as wheel and compressor."

MISTAKES IN DRAWING THE LINE ON OPERATING COST

The generally excellent and practical text book, "Examination Questions for Certificates of Competing in Mining," contains a question relating to the probable cost of driving a tunnel 7.5 ft. x 9 ft. in the southern anthracite coal field, from the Primrose bed to the Skidmore bed, the measures pitching 30 degrees.

"Ans.—According to the sections of the State Geological Survey, the mean distance between the Primrose and Skidmore seams is 450 feet, and as the measures are pitching 30 degrees, the length of the required tunnel will be:

$$\frac{450}{\text{Sine of 30 degrees}} = \frac{450}{.5} = 900 \text{ ft., or } 300 \text{ yds.}$$

"The average complete cost per linear yard for driving tunnels 7.5 × 9 ft. will not be less than $40 for hand drilling, and therefore the total cost of the tunnel will be 40×300=$12,000. If compressed air were at hand to run the drills this cost would be reduced to possibly one-half this amount, but it would not pay to install a plant for this work only."

Mr. John E. Ambrose, General Superintendent Big Vein Pocahontas Coal Company, writes to *Mines and Minerals* as follows, questioning the practical correctness of the above answer:

If there can be a saving of one-half, or $6,000, by installing a compressed-air plant, I would by all means be in favor of putting it in. For instance, take the following estimate:

Air Compressor	$1,400
3 rock drills	600
2 tunnel columns	100
Air receiver	100
Air pipe	200
Contingencies	300
Total	$2,700

Or, approximately $3,000 for a plant to carry the work on to completion. The above is from a practical standpoint. Therefore, if by installing a compressor, we can do the work for half the money, or $6,000, and we can install a plant for $3,000, then we have saved $3,000 on the deal and and also have the plant on hand for any other work that may rise from time to time, such as overcasts, etc., or could sell it and it would bring 50 per cent. of its cost.

EXCUSES FOR "SAND HOGS"

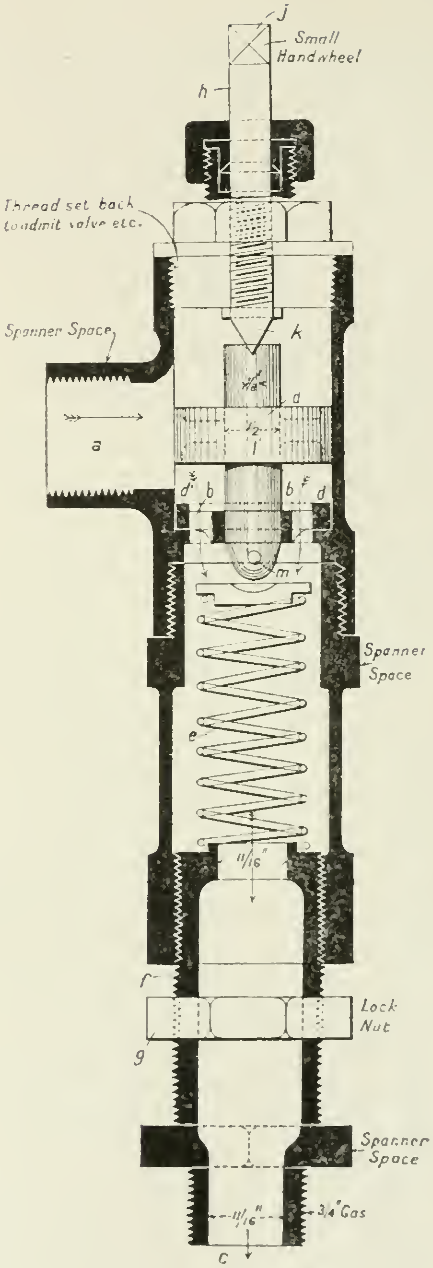
William Smith, a negro who had been employed in the East River tunnels, was recently found guilty in a New York court of stabbing a man in a fight over a crap game. He could have received five years in Sing Sing for the offence, but he got six months in the penitentiary instead. "Court records seem to prove," said the judge, "that, either because they breathe too much oxygen or are affected by the air pressure, sand hogs are more quarrelsome than the average man of other callings. They are constantly getting into trouble, and I think, in part at least, they cannot help it."

AN AUTOMATIC COMPRESSED-AIR-SAVING STOP VALVE

Compressed Air Magazine is alone responsible for the above descriptive title. The device shown in the cut (*The Engineer,* London) is known as the Atlas Isolating and Stop Valve, and is one of a series of "Titan" fittings made by J. Cowens & Co., Newcastle-on-Tyne, England.

There are sometimes leakages in compressed air systems, due to accident, neglect or otherwise. Sometimes the air is put to improper uses, such as the clearing of holes and the cooling of tanks and holds in warm weather, notwithstanding the fact that orders have been given that the air shall not be so used. The purpose of the valve here shown is to cut off the supply of air should the demand at any time exceed a predetermined amount. The valve will thus close should either the supply pipe be fractured or the air put to another use besides that of working the tool or tools arranged for. Not only will the valve close when a pipe is burst, but when the repair is effected it will automatically, after a short interval, recontinue the supply as before.

The valve is connected to the compressed air main by means of the screwed connection *a,* and when everything is working properly the air passes through the slotted holes *b,* as shown by the arrows, and away to the tool supply pipe through the orifice *c.* If, however, the demand for air increase beyond the point desired and arranged for, in a manner which we shall proceed to describe, then the rush of air carries the valve *d* along with it, forcing it on to the valve seat d^1 and cutting off the supply. The point at which this occurs may be adjusted within considerable limits. It will be noticed that in the chamber below the valve there is a spring *e.* The top of this is provided with a plate having a depression in it to receive the rounded bottom of the spindle of the valve—as shown in the engraving the plate is represented for clearness as not quite reaching the bottom of the spindle. The compression of the spring may be varied by means of the plunger *f* which screws into the chamber, and can be clamped in any desired position by means of the lock-nut *g.* The spindle of the valve has a ⅛-in. hole *l* drilled in it from the top nearly to the bottom, where, at *m,* the size of the hole is reduced to that of a pin's point. Arranged above the valve is a screwed spindle *h* with a point *k,* this point ordinarily resting in the top of and closing the hole *l* in the valve, as



AIR-SAVING STOP VALVE.

shown. This spindle is provided with a square top for the reception of a small hand wheel, by means of which the amount of pressure of the point *k* on the top of the valve can be adjusted. It will be realised that by this arrangement, when an amount of air beyond that wished for is passing the valve will close. It will be obvious that if necessary the valve may be used as a stop valve by screwing the spindle *h* down far enough to force the valve *d* on to its seat d^1.

We mentioned above that the valve, besides closing automatically, also opened in the same manner when, for instance, the tool pipe is repaired. Attention has been already drawn to the hole *l* in the valve spindle and to the pin-point hole *m* connecting with this hole *l*. As soon as the valve in being forced on to its seat leaves the point *k* of the spindle *h* air can find its way down the hole *l* and through the pinhole *m*. The amount of air which can pass is very small, and is allowed to go to waste, but it is enough as soon as the repair is effected and the system of piping, etc., made tight gradually to raise the pressure beyond the valve until it equals that on the supply side. At this moment, or perhaps even a little before it, the spring *c* asserts itself and forces up the valve *d*.. Operations can then recommence. It is clear that unless there were some such device as the foregoing, it would be impossible to reopen the valve when once it was closed without cutting off the pressure on the supply side. The valve is made to work in any position, but preferably vertical, and it is intended to be fitted close up to the supply main, and to take the place ordinarily filled by a stop-cock.

CHANGE OF LOAD APPORTIONMENT IN TWO-STAGE AIR COMPRESSOR

In a recent issue of *Power and the Engineer* a correspondent tells of a compressor breakdown and what they did about it. There was a motor-driven, cross-compound, 16 and 10 by 14 inch machine, delivering air at 100 pounds, gage; the back head of the high pressure cylinder was broken so that it could not be repaired and it would take two weeks to get a new one, while the compressor could not be spared for a day.

"There was an abundant supply of sheet steel scrap about the yard," the writer continues, "from which a blank flange was quickly cut out, drilled for free passage of air into and out of the head end of the cylinder, and for inlet and outlet for jacket water, and bolted on in place of the broken head.

"The machine was started up and worked very well; in fact, the results surpassed the expectations of the mechanic who proposed the repair. The low-pressure cylinder was taking almost the same volume it would take under ordinary circumstances, and compressing it to a higher pressure before discharging it to the receiver, on account of the high-pressure cylinder taking air from the receiver only on the back stroke. The relief valve on the receiver was set a little higher, and although the machine was out of balance, it was hardly perceptible in the running and the machine ran for the two weeks without a hitch.

"The question is, at how much less than its full rating did the machine operate? It took a little less air into the low-pressure cylinder on account of the increased clearance space. The receiver, being filled with air at a higher pressure, which expands on the intake stroke, would require less new air to fill the piston displacement."

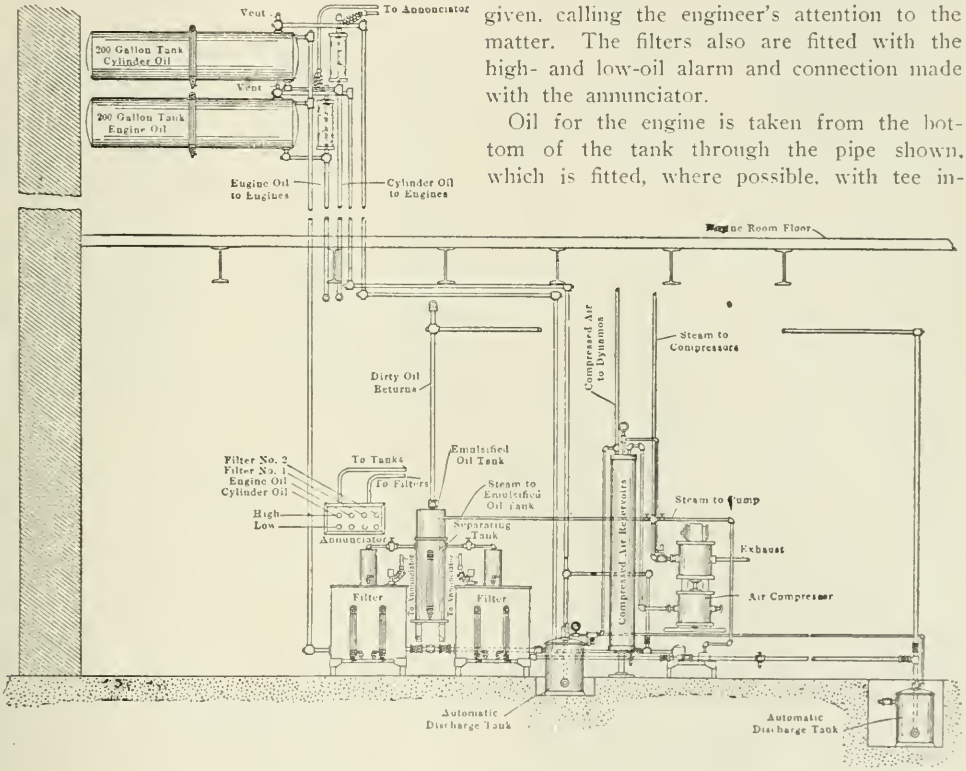
The free air capacity of a two-stage or multi-stage compressor is determined entirely in the low-pressure, or intake, cylinder, and the only thing outside of and beyond this cylinder which can affect its intake and output volume is the pressure against which it must deliver. The clearance in the low-pressure cylinder of course was not changed, but the pressure of the air remaining in the clearance space was considerably higher when one end of the high pressure cylinder was thrown out of use. The piston therefore upon its return stroke had to travel a greater distance before the clearance pressure had fallen to the atmospheric pressure, and before the intake of free air for the next compression stroke could begin; the total intake was therefore reduced so much and no more. In a high-class compressor the differance of output could, of course, be computed, but in practice it would be scarcely perceptible.

It is stated that in putting down the drill hole at Rybnik (Paruschowitz), Upper Selesia, which reached a depth of nearly 7,000 feet, the cost of the carbons used was $25,000.

AUTOMATIC AIR OPERATED OILING SYSTEM

The accompanying cut, from *Power and the Engineer* shows diagrammatically the essential features of an air operated oiling system in successful operation in the power plant of Johnson & Johnson, New Brunswick, N. J. The system was designed by William Peterson and was installed by the Vandyck, Churchhill Company, 91 Liberty street, New York.

The oil supply tanks are located in the top of the engine room higher than any portion of the engines to be served. Each bearing of the engine is fitted with suitable connection to the oil main, and the engine oil, besides being piped to the bearing, crosshead, etc., is piped to oil sinks placed between the high- and the low-pressure cylinders of each of the three large engines. Another oil line furnishes cylinder oil to the lubricator, while a third pipe line conveys the dirty engine oil to a separating tank and emulsified-oil heater.



The illustration shows an elevation of the filters and other devices necessary to deliver the filter oil to the elevated storage tanks, each of which is fitted with a gage glass, the connection of which passes through the brick walls so that only the gage glasses show in the engine room. Each is also fitted with a high- and low-oil alarm, as shown at the end of each tank. It is operated by means of a float, which rises and falls according to the height of oil in its respective tank. By means of suitable connections, contact is made with the terminals of wires connecting with an annunciator located above the oil filters. If the oil in the cylinder or the engine oil tank is too high or too low, the proper signal is given, calling the engineer's attention to the matter. The filters also are fitted with the high- and low-oil alarm and connection made with the annunciator.

Oil for the engine is taken from the bottom of the tank through the pipe shown, which is fitted, where possible, with tee instead of ell joints. One end of each tee is plugged, thus allowing quick cleaning out of any obstruction that might become lodged in them.

After the oil has been used on the engine it is returned to the emulsified-oil tank, which is located just above the separating tank. Steam for heating the dirty oil is obtained from the steam pipe furnishing steam to the air compressor. After the oil and water have separated, the oil flows to either or both of the "White Star" filters, from which it flows by gravity to the automatic discharge tank. As the oil rises in this tank it operates an air valve by means of a float, which lifts an inlet-air valve, letting in air at a pressure of 35 pounds. This pressure closes the check valve in the pipe leading to the filters, and at the same time forces the oil to the overhead tank. When the oil has been driven from the discharge tank, the float drops and closes the air-inlet valve and opens the valve to the atmosphere, thus enabling the discharge tank to refill with oil. The air is compressed by a standard Westinghouse air brake pump which pumps air to the compressed air receiver shown.

The system is flexible, as the oil can be returned either from the oil filter of from any independent discharge tank to the emulsified-oil tank. This is done by two volute pumps, which are placed in a pit at a considerable depth below the level of the filters, and at the extreme end of the plant. The oil from the two engines flows to the automatic discharge tank, which is connected to the air-pump line, and as the oil lifts the float, the air-inlet valve also is lifted, as in the first case mentioned, and the dirty oil is discharged to the emulsified-oil tank, from which it flows to the filter.

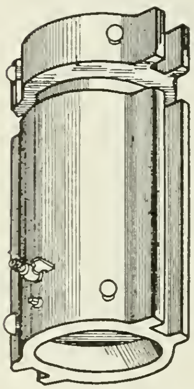
By this arrangement a continuous automatic oiling system is obtained which will stay in operation so long as there is oil. No trouble is therefore experienced with leaky oil-pump piston rods, packing, etc. Oil does not drip down on the floor and the entire arrangement makes a most satisfactory system for the power plant. Air also is piped to the engine room for cleaning out the generators, etc. The cylinder oil is elevated by means of a small duplex oil pump, pumping direct from the barrel to the cylinder oil tank.

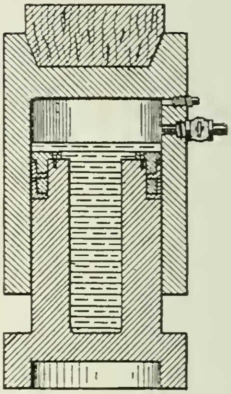
PNEUMATIC HAMMERS CLEANING MEDIEVAL CASTLES

Mr. Frants Alling, Member Danish Association Civil and Mechanical Engineers, writes us thus interestingly from Coperhagen:

"Under a two years' subscription to your valuable magazine I have learned of many different applications of compressed air. Still it seems to be left to old Denmark to put on record another use of compressed air not hitherto heard of: the cleaning of old castles.

"The ancient royal Kristiansborg castle, founded in the twelfth century and repeatedly burned, is now being rebuilt as a combined royal castle and parliament building. The joints in the brick walls of the basement were required to be cut out and cleaned to a depth of one centimeter. The job comprised several thousand sq. mt., and the contractor first tried hand labor for the work; then I ran up against the problem and advised him to use pneumatic hammers. After a convincing trial the contractor installed a portable electric driven compressor and five hammers, which were entirely successful. Here is a hint for other castle cleaners."





PNEUMATIC CUSHION CAP FOR PILE DRIVING

The device here shown, the invention of F. L. Aymond and C. C. DeWitt, of St. Louis, is of important service in preventing the shattering of the pile heads in driving reinforced concrete piles. It has been tried in practice and found effective under exacting conditions. The cut seems to be entirely self-explanatory. The main casting which sets on top of the pile has a large cavity for the reception of oil, which is of sufficient quantity to stand above the top of this piece and is prevented from escaping by leather packing rings. An inverted cylinder fits occurately over this, both these pieces having wings which loosely fit the guides of the pile driver. The cylinder has a cavity in which is inserted a renewable block of hard wood upon which the hammer drops.

The oil is poured in through the upper hole in the side of the cylinder and the plug is screwed in tight. A hose is connected to the stop cock and sufficient air pressure is produced in the cavity by an ordinary hand bicycle pump, and then the stop cock is closed and the hose disconnected. There is no opportunity for the air to escape. When the hammer drops the air is compressed, the cylinder moving down ⅝ to ¾ in. and immediately returning to normal position. The cap has been used with a steam hammer striking a 5 ton blow, 70 strokes per minute.

GAS PRODUCER PLANTS AND GAS ENGINES

Bulletin No. 416 recently issued by the United States Geological Survey and which may be had free of cost upon application to the Director, Washington, D. C., treats of producer-gas plants and gas engines in the United States. Prof. R. H. Fernald states that the internal combustion engine has already become a serious rival of the steam engine in many of its applications, and he calls attention to the rapidity with which practice has developed. Only nine years ago a 600 horsepower engine exhibited at the Paris Exposition was regarded as a wonder, but to-day four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 horsepower can be found in nearly all well-equipped steel plants, and some plants in this country contain several units rated at 5,400 horsepower each.

More than 500 producer-gas power plants, ranging in size from fifteen to 6,000 horsepower, are now in operation in the United States. About eighty-eight per cent. of these plants are running on anthracite coal, a few on anthracite or coke, and the remainder on bituminous coal and lignite.

The tests made by the Survey, 168 in all, included 138 on bituminous coals, nine on subbituminous coals, ten on lignite, and eleven on miscellaneous fuel. The average consumption of fuel for a brake-horsepower hour was 1.36 pounds of bituminous coal, or 1.99 pounds of lignitic coal, the minimum consumption being 0.84 pound and 1.48, respectively. Comparative tests of seventy-five bituminous coals under a water-tube boiler and in the gas producer showed that the average fuel consumption per brake-horsepower in the steam plant was 2.7 times that in the producer-plant. Several low-grade coals and lignites that were of little value, or even worthless, under the steam boiler gave excellent results in the producer. Other low-grade fuels—such as roof slabs, culm, and washery refuse, and even a bone coal that contained forty-four per cent. of ash—have been used to advantage in the producer under proper commercial conditions.

Professor Fernald sought the views of the principal manufacturers in this line and sixty-nine different plants furnishing power for a great variety of purposes were personally visited, resulting in the following conclusions:

That the plants as a whole are giving remarkable satisfaction in view of the brief period of development. That the most serious difficulty seems to arise from the lack of competent operators to run the plants, though there are many more competent operators today than three years ago. That the situation regarding misrepresentations and misunderstandings resulting from incompetent salesmen has with the stronger companies greatly improved. That the situation regarding trouble due to manufacturers neglecting plants that have been installed and paid for has changed decidedly for the better.

AIR HAMMER DRILLS

The following, which we abstract from *Mines and Methods,* may be taken as an impartial and intelligent statement of the present status of the hammer drill, especially as used in Western mines.

It is not many years since the first attempt was made to adapt pneumatic riveting machines to mine work, yet already air hammer drills have established themselves in a field of their own—overhand stoping in soft and medium rock—and are rapidly driving the large piston drills out of that class of mine work.

AIR HAMMER DRILLS NOT NEW.

The air hammer drill is only a reversion to the type of drill first tried, just as the steam turbine is a resurrection of Hero's engine. The first idea with machine drill inventors was to imitate the single jack, so for several years almost all the inventors were trying a moving hammer that struck the head of the drill a direct blow. Then Burleigh invented the system of attaching the drill steel to the piston or moving hammer head, so as to make the steel, for the time being, a part of the hammer itself. This was a success and seemed at the time a complete solution of the problem, so that the older type was abandoned and forgotten until it was revived by Leyner only a few years ago.

Small hammer drills soon followed, and so promising was the field and so many entered it that before long two well defined types were in vogue, the valveless and the valve machine, and which is the better is not yet apparent. One company makes a drill of each type, and this company, which should be unprejudiced, says that the two types are equally efficient and equally reliable.

VALVE AND VALVELESS TYPES.

Neither type of drill is without some objectionable features. Dust gets into the valve machine and clogs it occasionally. In the valveless machine, on the other hand, the piston may wear and the drill consequently lose its efficiency. Case-hardening minimizes this effect, and the case-hardening is no longer a film hardening but of sufficient thickness to outlast all permissible wear. So with the valve machines; by passing the air through the telescope feed so as to have it serve as a dust catcher, or by other devices, the entrance of dust to the valve is to a great extent prevented.

WHAT DETERMINES CHOICE OF TYPE.

Each class of air-hammer drills has its advocates, and in certain districts, apparently according to the type of first successful air-hammer drill that was used in the camp, we find either the valve or the valveless machine predominating. For instance; the Coeur d'Alenes is a "valve camp" and the Waugh drill is in the predominancy, although a good many other makes are used. At Butte the Imperial drill, the Ingersoll-Rand Company's valveless type, is the air-hammer drill most used, more than three hundred of these drills being at work in the camp; yet, here, also, other makes are used. At Bingham Canyon the Leyner No. 5 stoping drill is mostly used. This is a valve machine. In each of these districts several types of drills were tested before the large companies made a decision.

The whole gist of the matter seems to be that all the air-hammer drills are better for drilling up-holes in soft or medium hard ground than the large or small column-mounted piston drills, because less time is consumed in setting up, and because the repairs are less. It appears, though, despite the claims of the respective machinery companies, that there are four or five air-hammer drills that are about equally good. Indeed, the Amalgamated Copper Company tried all the leading air-hammer drills in their mines for a considerable length of time before they made any decision. Several of the machines gave practically the same results—the Imperial, the Waugh, the Sullivan and the Murphy. So, as the company was using Ingersoll-Rand Company piston machines—Ingersolls at the Anaconda, Washoe and Syndicate mines, and Rands at the Boston and Montana mines—the Amalgamated company chose a drill made by that company.

The Amalgamated officials favored a valveless machine, owing to the one less moving part, and because they thought that the lighter, quicker blow struck by the valveless type of the Ingersoll-Rand Company was better adapted to drilling in soft as well as in hard rock than the heavier, longer blow struck by the valve type.

At Butte the use of air-hammer drills is almost entirely confined to stoping and driving raises, still a Murphy sinker weighing approximately 70 lb. was tried in sinking the new Gagnon shaft. This drill gave excellent satisfaction down to a depth of about 100 ft. but beyond that depth the rock became too hard for efficient work with an air-hammer drill. The Murphy drill was not used entirely even to this depth, for some of the drilling was done with piston machines.

TYPE OF STEEL AND SHAPE OF BIT.

At Butte cruciform steel is favored, as it only requires flattening and hardening but not tempering at the chuck end, to render it ready for use. Hexagonal steel requires shanking and does not aid in conveying the drillings out of the hole. At Butte the heavy type of ribbed steel is used. A regular crossbit is used on starters and on finishers. At some of the mines this bit is crowned, the bit edges sloping away at an angle of twenty degrees to the horizontal. It is claimed that with this bit the hole is less liable to fitcher and that the drill rotates easier in the hole. It is favored at the Anaconda mines that are under the superintendence of Jack O'Neil. At some of the other Amalgamated mines the regular flat cross-bits are preferred.

The Imperial drill, size MC-22, is used. This, as has been said, is a valveless type. It weighs about 70 lb. These drills are used in the square-set stopes and also in those where the mining is done by the "back-filling" system. One man can drill in the Butte ore from 18 to 40 ft. of holes in an eight-hour shift. The speed varies, of course, according to the ground. Some of the holes are drilled as deep as six and a half feet, but the average depth is between five and five and a half feet. The starters have a two and three-eighths inch bit, while the finishers have a one and a half inch bit. There are five drills to a set, the finisher being seven feet long and the regulation starter one and a half feet long, but both first and second starters are provided, the second starter being two and a half feet long. A one and a quarter inch heavy-section, cruciform steel is used.

Throughout the mines one man will drill more ground with a hammer drill than two men will with a piston drill. As a result the cost of stoping has been reduced 25 per cent. wherever the air-hammer drills have been used. The company has been using the drills about six months in large numbers and is ordering more. It soon will have more than 300 air-hammer drills in operation. The repairs seem to be small and the machines seldom get out of order. The Amalgamated company is much pleased with the Imperial drill, but does not think it better than some other of the makes. When other drills showed no better work than the Imperial it was simply business for the Amalgamated Company to buy from the company with which it had been doing business for years.

The Imperial type of air-hammer drill has many commendable features. The cylinder is made in two parts, bolted together by two side bolts, and these side bolts fasten the head-block and the cylinder together, instead of having the head-block screw on. The inner tube of the telescope feed and the head-block are in one piece, being forged together so that they cannot come apart. A thick case-hardening is obtained on the cylinder, the main wearing part. Lugs are cast on the stuffing box so that it can be tightened without the use of a wrench. The air is fed into the telescope feed and then into the inner tube, so that the feed is made to serve as a dust catcher. Another small improvement is the use of a fish-tail pointer at the end of the telescope feed, so that the throttle valve is held in a permanent position until the hole is finished. The latch which fastens the head to the feed when moving the machine from place to place engages with a groove on the head-block, and so can be fastened with any position of the cylinder head. The air consumption with this drill is about 44 cu. ft. per minute, or about a third that of a three and one-eighth inch piston drill.

EDUCATING THE PROFESSIONAL ENGINEER

The following from the London *Times* may be taken as the advanced English estimate of educational requirements for the engineering profession:

It is too often assumed that because a boy shows an intelligent interest in mechanical toys and such articles he is likely to make a good engineer. Such mistakes were frequent in the past, but now that an engineering education has become so much more arduous—and in many cases more costly—than it used to be, these errors of judgment are less common. It was once usual to allow a youth to choose the engineering professison, with the freedom from heavy college or University expenses which then existed; further, owing to the early age of entering engineering works, additional bait was offered by lowering the expenditure upon school education. Happily, that is now a matter of the past, for an engineering student of to-day deprived of all training other than that picked up in a workship would soon find himself in difficulties when he had to compete with fully trained men.

The more elaborate training now considered necessary places the engineering profession on the same general scale of expenditure in time and money as the other professions; and there is not, therefore, any considerable financial inducement to put a boy into engineering without an assurance of a real measure of his ability for such work. It is important that a boy should not be allowed to imagine that by choosing the engineering profession he will avoid having to go through the usual schoolroom study of the "humanities" before specializing in engineering.

BETTER GENERAL EDUCATION REQUIRED.

The demand and necessity for men with a

higher standard of general education is becoming more and more apparent in the engineering profession. The lack of it in the past is still greatly felt, for the importance of this side of the question was overlooked in the eighties and nineties, when so many young men set out to be "electrical engineers." An impression seemed to have been circulated that any dextrous handler of a slide rule, and of certain formulae, was fitted to call himself an electrical engineer, and to this day the electrical industry bears traces of this idea.

There is the additional advantage in making a boy go through the usual curriculum in the non-engineering subjects that the presentation of these studies will often open up new fields of work for which it may happen that the boy will in the end prove to be better suited. The story of Huxley's choice of a profession is an illustration of this. His early wish was to become an engineer, but, as events proved, his real abilities lay in the direction of zoology. It is indeed a commonplace experience of all professions that many who embark on them find out that they have mistaken their life's work. To minimize these unfortunate accidents the best remedy is for the early education to be so widened that a better knowledge is obtained of the multitudinous fields of work that the world offers.

The ideal training for an engineer is a good public school education, followed by a course in engineering science at a University, passing thence for two or three years to engineering works of an approved character. This period ought to allow adequate time and experience to fit the young engineer to know how to handle men and how to make his personality felt wherever he may be. The training of character and the development of personality are of fundamental importance in engineering, as in the other professions. The cost of public school and University training is high, but few realize how increasingly easy it is for keen youths to pay their way by means of scholarships, particularly if they are mathematically inclined. The University training is the most costly, certainly not less than $750 a year, but numbers of keen young men have obtained as much or more than this by means of scholarships, and so have paid their way through the University. There are now a great many universities where fees are on a more moderate scale, and for those who cannot afford even these there are numberless polytechnics and technical schools scattered over the country, where scientific and technical education is given. It is difficult to give useful figures of cost, as the personal factor enters so largely. One may say that a University training, together with three years in works, will cost not less than $5,000, whereas at a non-residential University, near to the student's home, the scale of expenditure would be probably less all round, and perhaps $3,000 is as fair an estimate as can be made.

Some years ago a committee of the Institution of Civil Engineers (London) appointed to inquire into the "best methods of education and training for all classes of engineers," published a report recommending that the age of leaving school should be not less than 17, that the period of college study should be three sessions, and that the works training, for all except civil engineers, should be about three years, exceptions being made to suit particular cases. Thus to take the case of the average engineering student, he will enter college at about 17, will remain there until he is 20, and then go into works until he is 23. It is not easy for the young engineer whose training is just completed to get suitable work immediately he is ready for it, nor on the other hand is it easy for the employer needing a man at once to find one that will be all he wants; the feelings on both sides are much the same—a feeling that the good men or good berths must be somewhere, but that they are difficult to find. This only means that an "honest broker" is wanted, and if some responsible organization of this kind were in existence, there is little doubt that the profession would greatly benefit.

During August the record dredge on the Yuba handled 309,000 cubic yards. In the argonaut days it kept a placer miner busy to handle four cubic yards. One dredge of 1909 is doing, therefore, the work of 2,500 miners of '49; and, as sixty dredges are to-day giving California's auriferous soil a shakedown, their combined work foots up fully the output of an army of 150,000 pick-and-shovel miners.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
FRANK RICHARDS, - - Managing Editor
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H. L. KEELY, - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. APRIL, 1910. No. 4

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RESPECT THE ROCK DRILL

If we were to ask one only casually acquainted with the rock drill to tell us what it is and what it does, we would perhaps learn from him that it is one of the simplest machines, its sole function being to reciprocate a piston with considerable rapidity, the piston carrying a steel bit which by constant forcible striking of the rock gradually crumbles its way into it, forming a hole of any required depth. This would not be an untruthful statement, but it would be an absurdly inadequate one. The simple fact is that there are few accepted inventions which so completely satisfy so many imperative and exacting conditions as does the rock drill.

The drill in a way does rough work, rough surroundings are its habitat, and it is handled and operated by men who would also, perhaps unthinkingly, be characterized as rough. It must, therefore, in itself be rough and strong exteriorly, so that it can stand the most strenuous use and unlimited abuse. It must be able to put in holes in the rock in any direction, vertically downward or vertically upward or at any angle between, and in any vertical plane all around the circle. It must be set in the required position quickly and precisely, and while drilling each individual hole it must be held accurately and securely, yet never rigidly, in position and direction, and provision must be made to constantly feed forward the drill as the steel advances into the rock and to withdraw it for changing bits or for starting another hole. This suggests the requirements for the drill mounting, which are entirely separate from those of the drill itself and are trivial in comparison.

Perhaps the most important and responsible detail of the drill is its valve and valve motion. There can be no positive valve motion as with a steam engine, for the double reason that the stroke of the piston in the drill cylinder constantly varies and that if an otherwise satisfying mechanical movement and connections could be devised the mechanism would be soon demoralized by the jar of the machine; and yet the valve must and does admit the air or steam freely so that the piston moves with the required force; the piston must normally avoid striking the cylinder heads, and whatever the position of the drill or of the piston in the drill cylinder it must always and instantly obey the throttle. The possibility of occasionally striking the cylinder heads seeming to be unavoidable they cannot be rigidly secured to the cylinder but must yield a little upon occasion for their own salvation.

The drill bits of course wear in use, and in hard or gritty rock the wear may be rapid, so that it must always be possible to change a steel for another, the chuck must therefore hold the bit securely under the shock of the repeated blows, and yet it must be tightened or loosened without delay. This constant changing of bits, and the minute movements of the shank in the chuck under the repeated blows, of course entails wear, which must be provided for so that the rectilinear truth of the successive bits when inserted may be relied on.

Constantly, while the steel is advancing into the rock it must be kept in rotation, the turning of piston and steel not having any regularity of angular movement, but still insuring that the cutting edges of the bit shall each time strike in a different place. The automatic rotation provided, while it insists upon the turning of the piston and bit more or less at each stroke, still does it in a yielding way, so that accidents or breakages do not occur if at any time the bit refuses to be immediately turned as much as the rotation device would normally require.

It was conceded at the beginning that the rock drill is in a way a rough machine, and yet in the details of it there is scarcely any machine so carefully made and so precisely sized in all responsible dimensions. The drill, for instance, is, as we know, normally driven by compressed air, and the readiness of compressed air to leak away wherever it finds the chance is more than sufficiently notorious, and yet the cylinder heads, the valve chests and other parts requiring air tight joints are so perfectly surfaced and fitted that they go together, and are always used, metal to metal, absolutely without packing.

The rock drill lives the strenuous life. It is necessarily subject to severe wear, much abuse and neglect and frequent accident, so that its parts are liable to require renewal or replacement at any time. Every part of every standard drill is made so accurately to gages that stocks of such parts are maintained wherever the drills may be employed in any part of the world, and these parts interchange with and replace each other as though there were but one machine of its type and size in existence.

The production of the rock drill as it is today imperatively requires the co-ordination of many exacting conditions. After the drill has come to be practically adapted to its line of work by the succession of innumerable inventions, the trying out of the successful details, the determining of the absolute and the relative sizes of the several parts for their mutual co-operation, the selection of the most suitable and enduring material for each part and its proper treatment to secure strength and non-wearing qualities, the system and means of manufacture are to be secured. This means carefully collected and long experienced workmen, installations of automatic and often special machinery, costly collections of gages, jigs, templates, drills, taps, reamers and original tools for individual operations, and then the breaking in, the testing and the rigid inspection of the product before it is sent out.

QUANTITATIVE VS. QUALITATIVE INVENTION AND ENGINEERING

At the dinner of the Alumni of the Schools of Science and the School of Architecture of Columbia University, at Hotel Astor, New York, February 2, 1910, what we must consider the most notable event was the highly suggestive address of Dr. R. W. Raymond, from which we take the following:

While I do not propose to define the engineer, I beg to suggest one element which characterizes, I think, all true engineers. And I will use as a name for it a term borrowed from the laboratory. The engineer's thought and work are quantitative, not merely qualitative. Engineering lies at the base of the edifice of civilization; but the progress of civilization is often erroneously measured by mere inventions. Now inventions may sometimes be made and must always be perfected and utilized by engineers. But inventors who are nothing more fare badly, as they ought to.

How often we hear the accusation that the world has ill repaid the first propounder of an idea which in the hands of another has proved greatly profitable. But, in truth, it is not the happy thought about a thing, but the practical doing of the thing, that deserves reward. No doubt the first man, looking at the first bird, wanted to fly, and tried to fly, but the trouble was, he couldn't fly. Should we now hunt up his heirs, and pay them for the invention of their ancestor? His work was merely qualitative.

QUALITATIVE INEFFICIENY.

Once upon a time, a pale, inspired inventor climbed up to my office, and asked me to help him to go to Colorado. He had invented the idea of using electricity in mining and metallurgy; and he wanted to go to the Rocky mountains, because at their summit electricity was so abundant. His notion was a qualitative one. Yet, no doubt, if he is still alive, he cherishes the notion that he has been robbed of the glory justly due to him for his bright idea.

These qualitative enthusiasts grow more and more numerous every year, with the increase in half-educated practitioners of "applied science." And the old errors continuously crop out anew. After every big snowstorm, we have a number of qualitative proposals to remove the snow from our streets by thawing it with steam jets, and letting it run away of itself. What is still more remarkable, the editors of our leading newspapers gravely publish such communications, under the impression that there may be something in the notion, and that they had better not disparage it lest haply they be found fighting against science.

After the great blizzard a storekeeper in Brooklyn undertook to apply quantitatively this qualitative proposition. Having a 16-ft. heap of snow opposite his store, and a cellar ful of old boxes under it, he dug in the drift a chamber with a chimney, crammed his stove with the kindling wood from the cellar, lit the fire, and waited for the mountain to disappear in fervent heat. He, being a qualitative thinker, did not know the difference between temperature and heat units, or dream of the amount of work he was expecting his little fire to do. When he had burned all his wood, he abandoned his faith in science.

I could multiply such illustrations indefinitely. But I may be permitted, in conclusion, to say generally and inoffensively, that qualitative thinking is one of the dangers of our day. Great popular manias, fads of special reform, exposures of public evils or hardships, appeals for governmental interference, all are, or are likely to be, merely qualitative. I think it was Thomas Jefferson who said, in substance, "A free people never loses its liberties by surrender to force. It gives them away in moments of enthusiasm."

It is the duty of engineers, who have been trained to regard and handle things quantitatively, to contribute this needed element to the thought and action of their time.

Let them make no haste to conclusions; let them count the cost, measure the means, weigh the sacrifices, appraise the gains and the losses—in a word, hold fast to the distinction between heat units and mere degrees of temperature.

PNEUMATIC MAIL DISPATCH TUBES IN NEW YORK

Before the end of the present year the city of New York will have an underground pneumatic mail transmission service more than twenty-five miles in length and superior to any other in this country, or perhaps in the world. This will by no means complete the system, as further long extensions will soon be required to keep pace with the rapid and continuous growth of the city.

At present a line of tubes extends north from the General Post Office on Broadway to 124th street on the west side, about 8 miles, a line of about the same length returning down the east side, with two cross lines connecting these and several special branches to stations off the main lines. There is a line across the Brooklyn bridge and extending up into the heart of that Borough. Besides the line over the bridge another will soon be demanded to connect the Borough of the Bronx with the system. This will require a tube under the Harlem River, as the bridges have draws which are frequently opened.

The system is by no means as simple in its layout as here sketched. All lines are, of course, in duplicate to provide for transmission in both directions. The long lines of tubes spoken of are not traversed continuously from end to end, but, extending through a chain of sub-stations, the carriers are driven along from one station to another until the destination of each is reached, wherever it may be. The stops at the stations are very short, and the speed between them is 30 miles an hour. In going, say, from the General Post Office to 124th street, or vice versa, although a carrier must be handled and restarted at each station, the total delay is only 8 minutes. The air pressure used is only two or three pounds with five pounds the maximum, and electric driven compressors or blowers at the stations provide relays which maintain the pressure as required, although not all the stations are pumping stations.

The uniform bore of the tubes is 8 inches and the carriers are two feet long. These are made of galvanized sheet steel, and while as light as possible each is capable of carrying six hundred letters at a time. While they are quickly opened or closed they are perfectly water tight. The bands near each end are made of a combination of rubber and canvas, and only these come in contact with the tube surface. These enlargements on the body of the carrier make it possible for it to round curves of eight foot radius in the tubes without binding. Each carrier has a ticket specifying its destination inside the head, but it is also legibly marked by a chalked letter outside, so that it is not opened until its journey is completed.

An able writer recently contributed to the *N. Y. Herald* a detailed description of the inside and practical working of the system as follows:

When a car is sent from the General Post Office up the west side it will go first to Station V, at Oak street. If the destination dial reads for a station in the northern section of the island the operator at Oak street will immediately upon the car's arrival slide it to an entrance gate and send it along to Station O, in West Seventeenth street. At this station will be found a pumping station and the car will then be tranferred to another section of tubing, which extends to the Long Acre square station, in West Thirty-ninth street. After being rehandled twice more the car will reach the next terminal, at West Eighty-fourth street. The last pumping station on the west side is at West 124th street, and if a car is intended for the Manhattanville district here it will stop. If it is for the Bronx it will be sent across town to the 125th street station, at Lexington avenue, where it will be met by wagon or automobile.

Special precautions have to be taken to prevent a too rapid despatching of the carriers, for that purpose a trigger has been placed in the transmitter and after a car has passed into a chamber free from air, from which it passes into the main tubing, this small trigger snaps back. Finally when the car has been blown into the main line this trigger falls into its natural position, indicating that the line is clear.

TWO STYLES OF RECEIVERS.

Two forms of receiving apparatus are used. The necessity for two forms is due to the fact that some of the post offices are equipped with pumping machines and some are not. The ones which are not supplied with compressors constitute way stations, while the power stations are terminals. The difference is that at the terminal stations the pressure in the receiving tubes is reduced practically to atmosphere and the opening of the gate to allow of the discharge of a carrier does not cause any air under pressure to be blown into the room, while at a way station the air is at least two pounds above the atmosphere. However, entrance gates have been invented and when a car reaches a way station it has to pass into a chamber controlled by a sliding gate, from which it is blown out into the room by a small amount of pressure, which is created in the chamber.

It is most interesting to watch the entrance of a carrier. It's approach is announced by a slight rumbling sound, the first gate closes, the second opens and the carrier is shot out into the receiving trough. The second gate closes, the first again opens and the car rolls to the front of the trough, where an operator picks it up, notes its destination and if not intended for his station he despatches it on to the next place.

Occasionally a carrier becomes stuck in the tube, caused by some dirt or other foreign substance having fallen into it. If a cave-in occurs on the line of the tubing it is liable to be severed from the remainder of the tube. When such a break occurs it is quickly detected and if an increase of compressed air cannot dislodge the car it will be necessary to tear up the street and extricate the car from the tubing.

FEW BREAKS.

Seldom does a serious break occur in the tubing, but when it does it is desirable to know just where the carrier is stuck. This is ascertained by "bleeder valves" in the pipe located at short intervals, to which a street manhole leads. By noting the pressure the location of the car can be roughly determined between any two of the "bleeder valves." There are also other ways of calculating the location of lost cars.

At the present time the system is so arranged that a block in the line cannot occur below Thirty-ninth street, and when the loop is completed it will be impossible to halt the work in any part of the city other than in the particular section where a car is stuck. Now when a car is stuck below Thirty-ninth street on the west side all southbound mail can be sent across the town to the east side and thence down to the General Post Office.

It will be just as simple to overcome a block when the entire line is completed as it is now to prevent one below Thirty-ninth street. If a car should be stuck at West Sixty-ninth street the mail for the stations above there could be sent up the east side to 125th street, across town to Eighth avenue and thence back down on the west side.

There are 1,400 carriers in daily use in the New York system, each one making a number of trips every day. They will last about eight months and will travel from 12,000 to 15,000 miles before requiring new bearings. Twenty post offices in Manhattan and two in Brooklyn are now served by the system.

ALGAE AND THE AIR LIFT

In a paper read recently before the Indiana Sanitary and Water Supply Association, Mr. J. B. Martin, the author, gave it as his opinion that compressed air had caused or promoted algæ growths in the water supply of Frankfort, Ind. The supply for this city is drawn from a 30 ft. stratum of water, bearing sand and gravel, lying between strata of impervious blue clay. In 1892 an air lift was used to aid the flow, since the ground water level had been gradually receding for some time At no time prior to the use of the compressed air, the writer stated, was the taste or odor of the water objectionable, but after its use growths of algæ were such a constant source of trouble that the air lift method was finally abandoned in 1907, after being used fifteen years. While the air was used the water was discharged into two covered brick storage reservoirs, waterproofed on the inside and cleaned regularly, so that the presence of the algœ could not be attributed to exposure of the water to sunlight. After the air lift method had been superseded by impeller pumps in the wells algæ caused no further trouble.

It does not appear that any provision was made for fitering the air entering the compressor, which should have been the first thing thought of in an installation for such service.

SAND BLAST PRACTICE IN ENGLAND

While the sand blast was used earlier and has been more extensively employed in the United States than on the other side of the Atlantic, it has found full appreciation in many localities over there, and practice has developed along original lines sometimes more advantageous than our own. For the cleaning of foundry castings we have generally used sand blast tumbling barrels of the intermittent type, and for larger castings the hose and nozzle in the hands of a workman.

A slowly rotating sand blast table, one-half of which is exposed for the placing and turning or removing of the castings operated upon, while the other half is hooded over, with a heavy leather apron in front across the centre of the table, is an arrangement which has many advantages. In the enclosure formed by the hood and apron there are fixed sand blast nozzles set at different angles so that they attack the castings on all sides and thoroughly clean them. As the turning of the table brings the castings out they can be removed by the men in charge and others substituted, or, if not sufficiently cleaned, they may be turned over and allowed to go around under the blast again. In connection with the table and blast nozzles exhaust pipes are so placed as to carry away most of the dust and give the men comparatively clear air to work in.

NOTES

The consumption of iron and steel in the Transvaal mines is estimated at 50,000 tons a year, valued at 4,500,000. Of this, $3,000,000 consists of rails, sleepers, pipes and fittings, rock drills, etc. The Central South African Railway buys about 32,000 tons of rails and sleepers annually.

What thermometer would be good for such weather as this? "Montreal, Que., Feb. 7.— Cold was so intense this morning that a Grand

Trunk locomotive, which had just backed into the Bonaventure station to pull out a train, froze to the track and delayed the train's departure for over an hour."—*N. Y. Commercial.*

A definite proposal is made for the construction of a tunnel between Denmark and Sweden, starting at Copenhagen and connecting with Malone. On the way two islands will be crossed where the electric car tracks will be carried to the surface. When the work is completed the trip can be made in an hour and a half.

The following question occurred in a certain examination paper: "What steps would you take in determining the height of a building, using an aneroid barometer?" One answer received was: "I would lower the barometer by a string and measure the length of the string." It is not every one who would be able to think of a barometer as a plumb-bob.

Contracts for the two 28,000-ton Dreadnoughts for the Argentine have been awarded to the Fore River Shipbuilding Company, Quincy, Mass., with the stipulation that they sublet one to another builder. These vessels will be equipped with machinery developing about 40,000 horse-power. They will cost about $11,000,000 apiece. Twenty-five shipbuilders of England, France, Germany and Italy competed for these contracts.

A peculiar accident happened recently to miners who were trimming the sides and roof of the Gunnison tunnel. They had placed several shots and had retreated to a safe distance. The force of the explosion reversed the air current, and eleven of the men engaged in the work were either smoothered at once, or so badly overcome by the gases that they died in a few days.

It is calculated that the United States now produces per week for each of its 90,000,000 inhabitants: of wire ¾ pound, more than ¾ pound of rails, ½ pound of structural shapes, ¾ pound of plates, ⅓ pound of sheets, ¾ square foot of tinplate, 2½ pounds of bars, hoops, etc., 4 pounds of iron castings. These and other finished iron and steel products make a total of 12 or 13 pounds each week per head.

Norway abounds in waterfalls, the water supply being quite constant throughout the year, partly owing to the altitude of the water sources, the condition of the climate, and the exceptionally high rainfall. The total water power of Norway amounts to about 7,500,000 h. p., giving 3,405 h. p. per 1,000 inhabitants of the country.

The pollution of air in mines is sometimes due partly to the emanation of gases from the surrounding rocks, but principally from the following artificial causes: (1) Respiration of persons and animals, (2) combustion of the candles and lamps, (3) absorption of the oxygen by pyrites and other minerals, (4) putrefaction of timber, (5) explosion of powder, (6) dust from boring, etc. Of these the decay of timber underground is the one having perhaps the most deleterious effect.

In some metallurgical operations steam is admitted to large vats or tanks for the purpose of agitating, and, in some cases, heating their contents. In special cases, the consumption of steam for this purpose is enormous, the reduction of which is often possible with better results by mixing air with steam. This may be accomplished by using an ordinary injector. To insure the proper working of the device, the steam is first turned on, then the valve of the injector gradually opened until the desired amount of air is obtained.

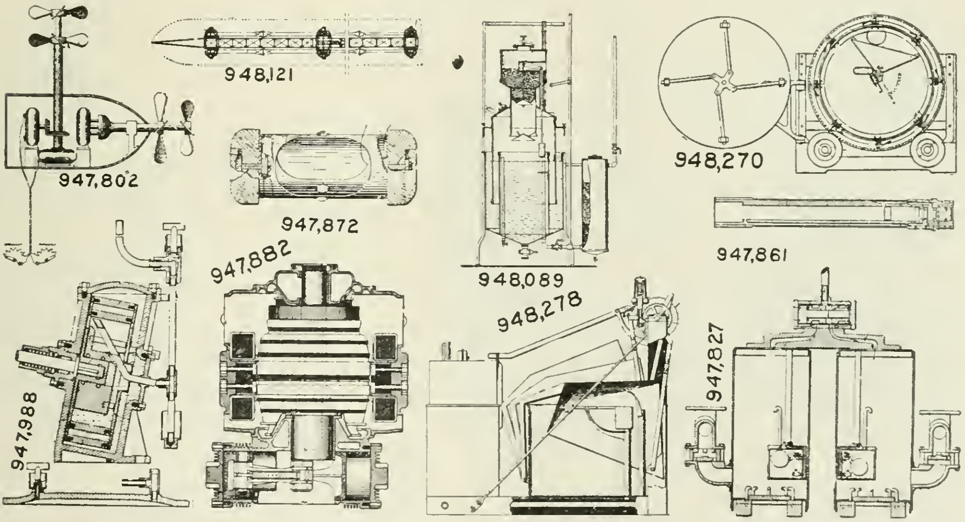
Mr. L. M. Hastings, city engineer of Cambridge, Mass., in his last annual report gives diagrams of the recorded rainfall at New Bedford since 1813. These observations were started by the father of the present observer, and have been conducted uninterruptedly ever since. They show in a rather striking manner that while there is a general undulation in the curve of the averages of both temperature and precipitation, there has been no appreciable change in the average character of the climate of the place, as indicated by these two factors, during the 95 years covered by the diagram.

Three men—the chief engineer, a keeper and a helper—were killed by an explosion of gas at Chocolay Furnace of the Lake Superior Iron & Chemical Company, at Chocolay, Mich. The furnace had just been blown in and the men had been at the top adjusting a valve. In returning they went by way of the machine shop and engine house instead of going down the outside stairway. As they entered the tank room on an upper floor with a lighted torch the explosion occurred, the room being filled with gas from the turning on of the blast.

A high-pressure submarine gas main, 4,000 ft. long, was laid under the bay from San Diego to Coronado, Cal., by lowering the pipe from a lighter down an inclined chute. The pipe was 4 in. extra heavy cast iron ball-and-socket pipe, and was received in 12 ft. lengths, with a standard joint at one end and either a ball or a socket on the other, so that a flexible joint occurred every 24 ft. The lighter was 90 ft. long and 24 ft. wide, and on it a chute, at an angle of 50 deg. to the horizontal, was built of two 80 ft. piles, spaced 4 in. apart and bolted together. A similar chute of two 100 ft. piles was hinged at one end to the scow and rested at the other end upon iron trucks, so that it could be dragged along the bottom of the bay. The pipe was connected up in 72 ft. lengths on the lighter and allowed to descend to the bottom along the inclined chute as the lighter moved forward.. The line was caulked by divers, and when tested to 75 lb. dropped only 10 lb. in twelve hours.

The microphone is being used with some success in France in searching for subteranean water. One end of a pipe, open at both ends, is thrust a little way into the ground, and the microphone is then used to magnify any sound that may come up the tube. Running water is said to cause a sound like that of the wind in a forest, and dropping water one resembling a bell. In a branch valley of the Marne, where there is a scarcity of water, the microphone has led to the discovery of two valuable springs 50 ft below the surface.

Calumet & Hecla has paid $109,750,000 in dividends on an issued capital of $2,500,000, and in 1909 earned $37.26 per share on a copper production of 69,000,000 lb. From January 1, 1905, to January 1, 1910, the average annual dividend was $47.20 on shares having a par value of $25 each.



Pneumatic Patents Febuary 1.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

FEBRUARY 1.

947,802. AIRSHIP. Arthur Crane, Berkeley, Cal.

947,827. VALVE MECHANISM FOR WATER-ELEVATORS. JOHN L. LATTA, Hickory, N. C.

947,861. PNEUMATIC TOOL. WILIAM H. SOLEY, Philadelphia, Pa.

947,872. PNEUMATIC CASH-CARRIER. WILLIAM H. UPHAM, Toledo, Ohio.

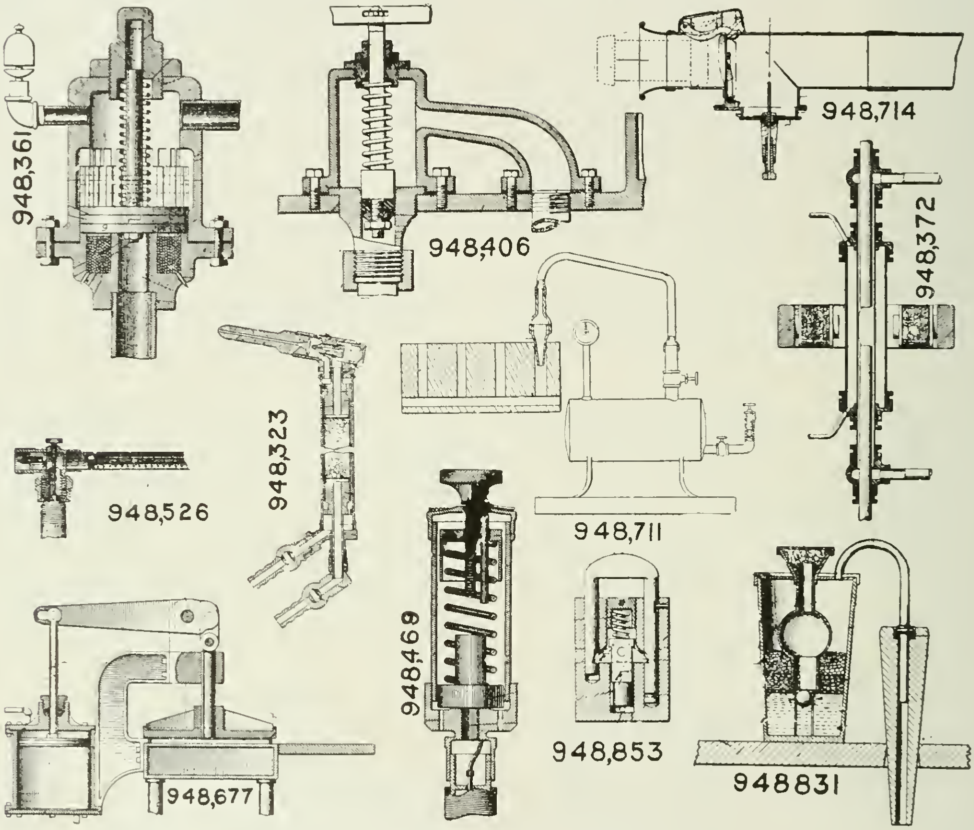
947,882. ELECTRIC AIR-COMPRESSOR. ASA F. BATCHELDER, Schenectady, N. Y.

947,988. ROTARY MERCURY VACUUM-PUMP. HENRY A. FLEUSS, Reading, England.

948,089. ACETYLENE-GAS GENERATOR. ALEXANDER DER and MICHAEL FISCHER, West Allis, Wis.

948,121. FLYING-MACHINE, AIRSHIP, AND THE LIKE. VINCENT WISNIEWSKI, Berlin Germany.

948,270. SAND-BLAST MACHINE. CHARLES A. DREISBACH, New Haven, Conn.



PNEUMATIC PATENTS FEBRUARY 8.

948,278. PUMPING APPARATUS. FRANK S. HEBDEN, Peoria, Ill.

2. In a pumping apparatus, an air reservoir including a tank and cover, means for pumping air to said tank, a bracket on the tank, a rod pivoted to the bracket, a link pivoted to the rod and cover, and means operated from said rod for controlling the operation of said pumping means.

FEBRUARY 8.

948,323. BLOWPIPE. JOHN HARRIS, Cleveland, Ohio.

948,361. TRAIN-STOPPING AND SIGNAL-ACTUATING MECHANISM. JEAN F. WEBB, JR., New York, N. Y.

948,372 PROCESS FOR PRODUCING OXIDS OF NITROGEN FROM THE AIR. FRANCIS I. DU PONT, Wilmington, Del.

948,404. AIR-OPERATED ELECTRICALLY-CONTROLLED VALVE MECHANISM FOR AIR-BRAKE AND TRAIN-STOPPING SYSTEMS. JEAN F. WEBB, JR., New York, N. Y.

948,469. PNEUMATIC SAFETY-VALVE. FRANK MOYLE. Jamestown, Cal.

948,526. TIRE AIR-PRESSURE GAGE. WALTER E. SANDHAM, Pasadena, Cal.

948,677. MATRIX-FORMING MACHINE. GLENN S. WILLIAMSON, New York, N. Y.

948,711. DENTAL CASTING APPLIANCE. ELZA R. STEALY, Dunlap, Iowa.

1. An apparatus for use in casting metal dentures including a chamber, a tube entering the same, means for exhausting air or compressing air into said chamber, a pressure gage connected to the chamber, a pipe extending from said chamber having therein a regulating valve, the exterior and interior faces of the end of said pipe being ground to form a joint, and an investment cup having a connection to said chamber through said joint.

948,714. PNEUMATIC-DESPATCH-TUBE SYSTEM. FRANKLIN H. WOLEVER, Chicago, Ill.

948,831. AERTING LIQUORS. AGOSTING TOSCO, San Francisco, Cal.

948,853. PNEUMATIC PADLOCK. FRANK J. GILROY, Buffalo, N. Y.

FEBRUARY 15.

948,989. SUBAQUEOUS ROCK-BREAKER. Barton H. Coffey, Elizabeth, N. J.

1. In a subaqueous rock-breaker, a lifting means consisting of continuous rigid and flexible elements connecting the rock-breaking apparatus and a primary hoisting means, such as a winding engine; in combination with a secondary hoisting means, such as a piston and cylinder, adapted to reciprocate the hammer or chisel through the said lifting means; for the purposes set forth.

949,069. STREET-SWEEPER. Oscar Grimwood, Owensville, Ind.

3. In a street sweeper, a framework, a pneumatic suction fan carried thereby, a rotary brush, pivotally mounted arms for supporting the brush, said pneumatic suction fan having a pneumatic suction pipe with its end disposed beneath and slightly in the rear of the said brush, connections between the suction pipe and the pivotally mounted arms in order to allow the pipe to have a yielding action, means for yieldingly holding the pivotally mounted frame downward, and means for operating the pneumatic suction fan.

949,080. PNEUMATIC TOOL. William H. Keller, Philadelphia, Pa.

949,095. PNEUMATIC SCISSORS. Ludwig Stephany, Philadelphia, Pa.

949,180. FLUID - PRESSURE - REGULATING DEVICE. George S. Goslee, Waukegan, Ill.

949,208. VALVE. Charles R. Ballard, Midway, Pa.

949,250. VALVE FOR PNEUMATIC MUSICAL INSTRUMENTS. George S. Williams, Norfolk, Va.

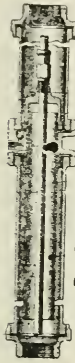
949,370. PNEUMATIC CLEANER. Azel C. Buell, New York, N. Y.

949,423. PUMP. Jesse B. Garber, Salem, Ohio.

1. In an apparatus of the character described the combination with means for including a flow of water there-through, of a mixing chamber, an air inlet to said chamber, a reciprocating air pumping plunger, a tube depending from said plunger, and a port in said tube adapted to deliver water into the mixing chamber following each charge of air thereto, substantially as described.

949,598. DIFFERENTIAL-PRESSURE GAGE. Bertrand J. P. Roberts, South Kensington, London, Eng.

1. A differential pressure gage comprising a fluid-containing U-shaped capillary tube and a pair of chambers of greater diameter than the U tube and connected to the ends thereof, the tube having an index therein which renders the gage *insensitive to differences of level or variations of pistons.*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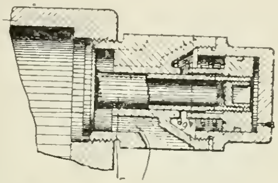
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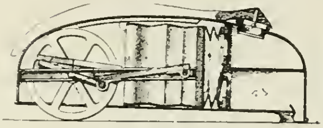
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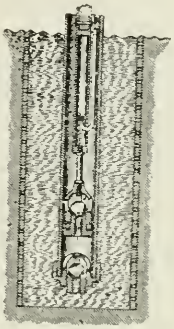
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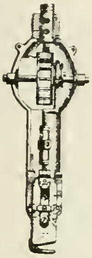

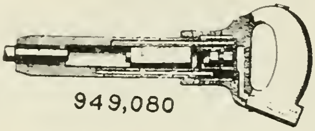
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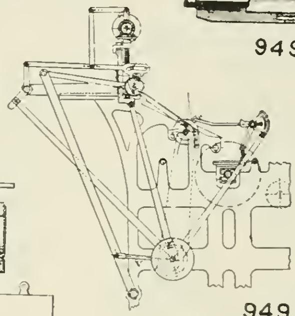
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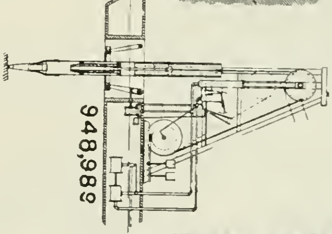
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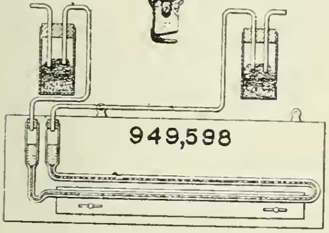
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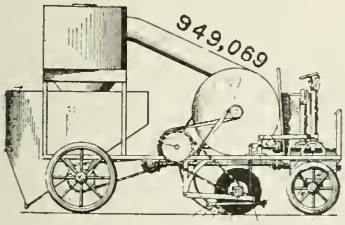
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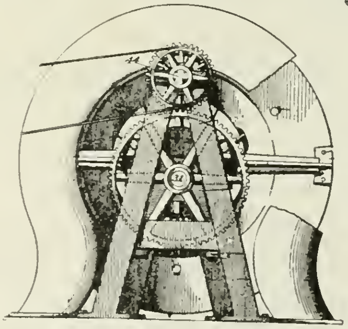
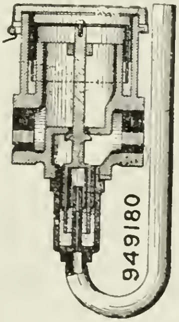



949180

Pneumatic Patents February 15.

949,625. PNEUMATIC SIEVE. Edward Dithridge, Morrisville, Pa.

A pneumatic sieve composed of a suitable sieve body, a supporting handle adapted to receive and transmit a jarring motion to said sieve body, and a cup attached to said handle of sufficient size to allow the *end of a pneumatic hammer* to enter and withdraw freely, and adapted to receive vibrations therefrom and to transmit the same to said handle.

949,681. DEEP-WELL PUMP. Ferdinand W. Krogh, San Francisco, Cal.

1. In a deep well pump, the combination of a piston, a hollow piston rod, an air chamber forming a part of said rod, and means for forcing air through said rod into said chamber.

949,714. ROTARY AIR-COMPRESSOR. Frank Peck, Rochester, N. Y.

13,082. SHEET-FEEDING DEVICE FOR PRINTING MACHINES. Gustav Kleim, Leipzig, Germany, (reissue).

1. In a pneumatic sheet feeding device, the combination or a plurality of sucking boxes, means for effecting a relative lowering and raising action between the same and a pile of sheets, and means for turning the sucking boxes arranged so that they will turn to bend the edge of the engaged sheet at an angle after they engage said sheet and so that they will run to normal position simultaneously with the raising of the engaged sheet.

FEBRUARY 22.

949,810. AIRSHIP. Jesse A. Turnidge, Webb City, Mo.

949,872. AIR-CYLINDER. Walter L. Abate, Mount Vernon, N. Y.

949,891. PIPE-CLEANING APPARATUS. William A. Hall, New York, N. Y.

1. In a cleaning apparatus, for pipe systems, or the like, the combination, with an air-tank or reservoir, of a cleaning compound reservoir or container provided with a measuring-device connected therewith, means adapted to connect said measuring-device, with a water supply and said air-tank or reservoir, and means adapted to connect said measuring-device to the pipe system, or the like, to be cleansed, substantially as and for the purpose set forth.

950,072. VACUUM-CLEANER. Jacob C. Luden, Reading, Pa.

950,115. PROCESS OF REMOVING TIN FROM SCRAP. Charles J. Reed, Philadelphia, Pa.

1. The process of separating metals which consists in heating and agitating the mixture with a subdivided foreign body and removing one of the metals as a powder by means of a current of air.

950,120. PNEUMATIC STACKER. Frederick L. Sattley, Indianapolis, Ind.

950,165. MEANS FOR RELEASING AIR-BRAKES AND ECONOMIZING AIR. William S. De Camp, Chillicothe, Ohio.

950,193. DRILLING MECHANISM. William L. Smith, Columbus, Ohio.

950,347. OZONE-GENERATOR, Robert W. Rice, Cleveland, Ohio.

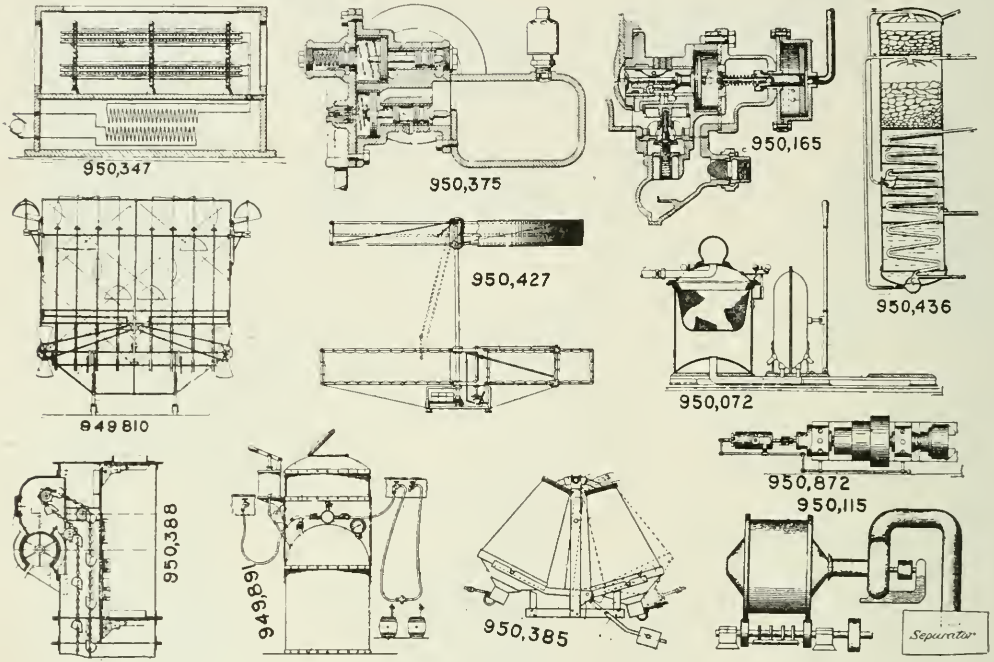
950,375. TRIPLE VALVE FOR AIR-BRAKE MECHANISM. Frank Y. Dibble, Ely, Nev.

950,385. MEANS FOR AUTOMATICALLY DELIVERING THE MILK FROM THE VACUUM-PIPES OF MILKING-MACHINES. Cyril E. Gane, Normanby, New Zealand.

950,388. AIR-LOCK FOR EXCAVATING APPARATUS. John H. Gray, East Orange, N. J.

950,427. AERIAL MACHINE. James Beard, Veterans' Home, Cal.

950,436. PROCESS FOR THE SEPARATION OF OXYGEN AND NITROGEN FROM LIQUID AIR. George Claude, Paris, France.



Pneumatic Patents February 22.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV MAY, 1910 No. 5

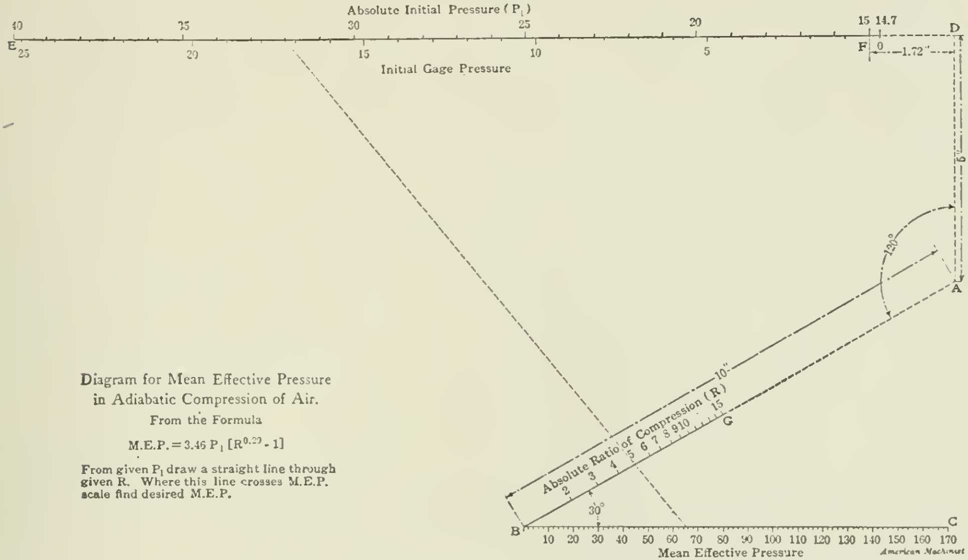

Absolute Initial Pressure (P_1)
40
35
30
25
20
15
14.7
D
E
25
20
15
10
5
F
0
1.72″
Initial Gage Pressure
5″
120°
A
10″
Absolute Ratio of Compression (R)
2
3
4
5
6
7
8
9
10
15
G
30°
B
C
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Mean Effective Pressure
American Machinist
Diagram for Mean Effective Pressure in Adiabatic Compression of Air.
From the Formula
$M.E.P. = 3.46 P_1 [R^{0.29} - 1]$
From given P_1 draw a straight line through given R. Where this line crosses M.E.P. scale find desired M.E.P.

Fig. 1. First Method of Constructing Air-compression Chart

MEAN EFFECTIVE PRESSURES IN AIR COMPRESSION

By H. L. Seward.

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Each of the accompanying diagrams consists of three straight-line scales so placed that if a straight-edge be laid across them, the readings of the scales where the straight-edge crosses them, will satisfy the formula:

$$M.E.P. = 3.46 P_1 (R^{0.29} - 1)$$

When any two of the three variables (M.E.P.), P_1 or R are given, the third may be immediately determined by laying a straight-edge over (or drawing a straight line through) the two given quantities and noting the reading under the straight-edge on the third scale. For example, if P_1 is given as 32 pounds per square inch absolute, and R as 5, then in Fig. 1, a straight line from 32 on scale P_1 through 5 on scale R shows that the M.E.P. must be 65.8. Or if P_1 is 20 and R is 7, Fig. 2, shows that the M.E.P. must be 52.5.

For the benefit of those who might wish to construct these diagrams on a little larger scale, the following method of construction is given:

Method 1. (Fig. 1).

At a point *A,* draw a vertical line *A D,* 5 inches long and draw $A\ B$ so that the angle $D\ A\ B = 120$ degrees. Make $A\ B$ ten inches long. At D and B draw horizontal lines $D\ E$ and $B\ C$, respectively. Upon $B\ C$ lay off a scale of 20 to the inch for the scale of M.E.P. From D measure $D\ F = 1.72$ inches as shown, thus locating the point 15 on the scale for P_1. From F continue the scale P_1 as far as desired, making the distance from one graduation to the next equal to 0.692 inch. If desired each space may be sub-divided into 10 equal parts so that the scale reads to hundredths.

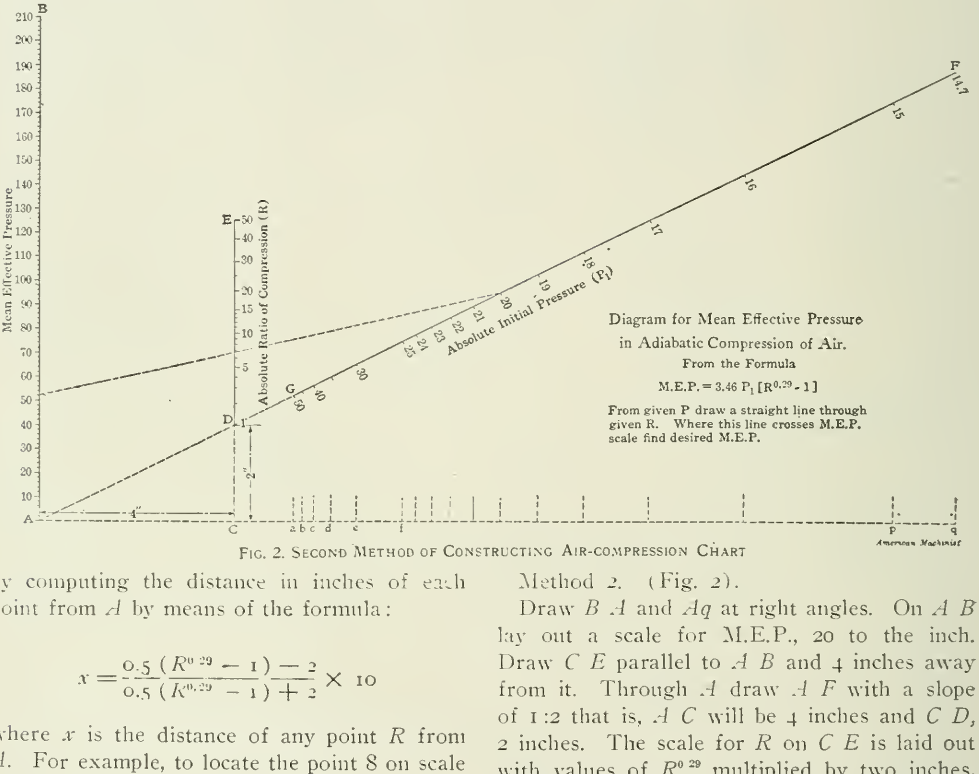

B
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
A
Mean Effective Pressure
E
50
40
30
20
15
10
5
1
D
C
4″
2″
Absolute Ratio of Compression (R)
G
60
50
40
30
25
24
23
22
21
20
19
18
17
16
15
14.7
F
Absolute Initial Pressure (P_1)
a b c d e f
p q
Diagram for Mean Effective Pressure
in Adiabatic Compression of Air.
From the Formula
M.E.P. = 3.46 P_1 [$R^{0.29}$ - 1]
From given P draw a straight line through given R. Where this line crosses M.E.P. scale find desired M.E.P.
American Machinist

FIG. 2. SECOND METHOD OF CONSTRUCTING AIR-COMPRESSION CHART

The points on the scale for R are located by computing the distance in inches of each point from A by means of the formula:

$$x = \frac{0.5\,(R^{0.29} - 1) - 2}{0.5\,(R^{0.29} - 1) + 2} \times 10$$

where x is the distance of any point R from A. For example, to locate the point 8 on scale R we have:

$$x_8 = \frac{0.5\,(8^{0.29} - 1) - 2}{0.5\,(8^{0.29} - 1) + 2} \times 10 = 6.57 \textit{ inches.}$$

The computation from this formula is not as difficult as it might seem at first sight, if carried on systematically. In the following table the values of R in the first column were written down one under another. Each one was raised to the 0.29th power by logarithms and results written in the second column. Then 1 was subtracted from each number in the second column to obtain the values in the third column. Values in the third column divided by 2 gave the fourth column of figures. Then each of the numbers in the fourth column was subtracted from 2 which gave the values in the fifth column. Values in the fourth column added to 2 gave the numbers in the sixth column. The quotient of numbers in the fifth column divided by numbers in the sixth, gave the last column. This last column, multiplied by 10 gives the desired values of x.

All three scales may be continued in length up to any desired limit.

Method 2. (Fig. 2).

Draw $B\ A$ and Aq at right angles. On $A\ B$ lay out a scale for M.E.P., 20 to the inch. Draw $C\ E$ parallel to $A\ B$ and 4 inches away from it. Through A draw $A\ F$ with a slope of 1:2 that is, $A\ C$ will be 4 inches and $C\ D$, 2 inches. The scale for R on $C\ E$ is laid out with values of $R^{0.29}$ multiplied by two inches. These values may be taken from column 2 in table above. For example, the distance from C to a point 9 on scale R is $2 \times R^{0.29} = 2 \times 1.891 = 3.782$ inches.

To plot the points comprising the scale for P_1 it is easier to locate the points $a, b, c, d \ldots\ldots q$ on Cq directly underneath. These are located from the formula:

$$x = \frac{-8}{-0.173\,P_1 + 2}$$

R	$R^{0.29}$	$R^{0.29} - 1$	$0.5\,(R^{0.29} - 1)$	A $0.5\,(R^{0.29} - 1) - 2$	B $0.5\,(L^{0.29} - 1) + 2$	A/B $\frac{e^x}{10}$
1	1.000	0.000	0.000	—2.000	2.000	1.000
2	1.223	0.223	0.112	—1.888	2.112	0.889
3	1.375	0.375	0.188	—1.812	2.188	0.829
4	1.495	0.495	0.248	—1.752	2.248	0.780
5	1.595	0.595	0.298	—1.502	2.298	0.742
6	1.682	0.682	0.341	—1.659	2.341	0.708
7	1.758	0.758	0.379	—1.621	2.379	0.682
8	1.828	0.828	0.414	—1.586	2.414	0.757
9	1.891	0.891	0.146	—1.554	2.446	0.636
10	1.950	0.950	0.475	—1.525	2.475	0.617
11	2.004	1.004	0.502	—1.498	2.502	0.598
12	2.058	1.058	0.529	—1.471	2.529	0.583
13	2.104	1.104	0.552	—1.418	2.552	0.568
14	2.150	1.50	0.575	—1.425	2.575	0.553
15	2.193	1.193	0.597	—1.403	2.597	0.539

For example, to obtain the point 30, we have:

$$Ce = \frac{-8}{-0.173 \times 30 + 2} = 2.51 \text{ inches,}$$

Locate point *c* 2.51 inches from *C* and erect a perpendicular to *C q* at e. Where this perpendicular crosses *A F* gives point 30 on scale P_1.

The two diagrams are two different arrangements of plots for accomplishing the same end. Fig. 1 is probably the more accurate of the two, due to the sharper intersections, but Fig. 2 would be more convenient in cases where higher values of P_1 are to be used.

AERIAL PROPERTY RIGHTS

The advent of the airship suggests some questions as to the ownership of the air and the rights of aerial navigation. The owner of land anywhere is assumed to own the air above it, and one who traverses the air must be technically guilty of trespass, in which there would seemed to be sometime some possibility of misunderstanding, and the question is what should be done about it, At a meeting of the Aero Club of America in New York, Mr. Littleton Fox suggested that the most effetcive solution would be by the assertion of the right of eminent domain. The State, he said, should condemn the air as a highway and take title to it, subject to the right of the land owner to build as high as he likes, or to make any other private use of the air above his land. Payment to each owner of whatever he should be able to prove to be the value of the air above his land should be provided. A cent apiece would seem to be ample compensation in most cases.

EMERGENT TREATMENT FOR LEAKY PISTONS

A writer in a recent issue of *Machinery* describes a makeshift treatment for reducing the leakage of gas engine pistons which in some cases might be available for air compressor pistons, and those of air motors. The method is, briefly, as follows: Take out the piston and take off the rings. Clean the piston rings and grooves thoroughly. Get a piece of soft abestoes rope and before putting the rings back into place, wind some of the rope in the bottom of the ring grooves in the piston. Then soak the asbestos thoroughly with gas engine cylinder oil, and put the ring back in the grooves. Put in enough of the asbestos rope so that the rings will have to squeeze it down fairly tight when the piston is pushed into the cylinder. This method may not be considered as a very mechanical job, but an old leaky piston when so treated will, after running a few minutes, be very tight, and may run for months before the operation needs to be repeated.

A BATH TUB FOR MULES

In the Henry colliery of the Lehigh Valley Coal Company the mine foreman, Mr. A. J. O'Malley, has introduced a bath tub for the mules in the mine, and it is pronounced a great success. When a mule is taken down into the mine he may be said to "leave all hope behind," as he seldom ever again sees the light of day, and this bath tub becomes an important feature in the lives of those who are privileged to enjoy it.

The tub is a concrete affair, some 40 ft. long and a little over 4 ft deep. It is built inside the mine just at the entrance to the mule stable. The long eared fellows are tired enough at the end of the day's work, and when they strike the bath they rush into it with evident glee, crowding each other for the deepest part of the tub. Directly over the water runs a perforated pipe, and when the shower bath is turned on the mules fairly neigh with pleasure at the exhilarating fun they seem to find in the invigorating treat. The speed with which mules will travel to the stable when the day's work is over is proverbial; yet with all their desire to reach their stalls and get the second meal of the day, they have to be driven by force out of the bath and into the barn.

Foreman O'Malley has received many congratulations upon the success of his scheme. There can be no doubt that he has evolved a plan which prolongs the vigor and vitality of the mine mule, a valuable asset for the company, but he has also provided a substantial means of pleasure for the beasts who have so little to break the monotony of their lives.

COMPRESSED AIR PIPE AND RECEIVER EXPLOSIONS IN THE TRANSVAAL

The following is from the Annual Report of the Government Mining Engineer for the year 1908-9.

The accident that occurred at the Langlaagte Deep, Ltd., on March 25, 1909, was the most serious of four similar occurrences in which explosions or firing took place in the discharge pipes or receivers of air compressors. At the Crown Mines, Ltd., there was a more violent explosion, but, owing to the great damage to the pipe line, which was absolutely wrecked in several places, no dangerous gas was delivered at the working places in the mine.

In the former accident, however, the resultant fumes from the explosion were discharged through a compressed air main into the mine and caused the death of ten persons and injuries to three others.

At the Roodepoort United Main Reef, Ltd., and the Main Reef, Ltd., there were cases of firing with no violent explosion and no mere serious damage to plant than the bursting of a few of the intercooler tubes, but in each case persons underground were gassed and there was one fatality. In these two instances the low-pressure side of the compressor appeared to be the seat of the trouble, but at the Langlaagte Deep and the Crown Mines the explosion occurred at the high-pressure valve chest or in the receiver.

All these accidents were followed by complete investigation into the attendant circumstances, but in no case could the actual cause be definitely assigned. There is, however, no doubt that the explosive mixture consists of air and the gases distilled from the lubricant deposits. It is possible that these volatile constituents of the oil may also carry very fine dust, which assists in lowering the ignition temperature of the mixture. Without allowing the possibility of sparks being created or very high local temperatures being caused by friction within the cylinders of the compressor, one has to regard the failure, partial or complete, of the water supply to jackets or intercooler as the probable reason for a rise in temperature sufficiently high to ignite the hydrocarbon deposit or the explosive gases distilled from this accumulation.

It may be mentioned that many tests have been made of the lubricating oils used in the compressor cylinders and these have invariably been found to have high flash points, i. e., above 600 degrees F. The ignition temperatures will, of course, be much higher than these flash points. The hydrocarbon deposit usually found in air receivers and pipes will burn and can be ignited with an ordinary match. In one case it was found that the carbonized matter taken from a compressor valve chest, when mixed with the lubricating oil, lowered the flash point of the latter. The substance seemed to cause a catalytic decomposition of the oil carbon and a more combustible gas. The analysis of this substance showed 30 per cent. of mineral ash, mostly iron oxide, but with marked quantities of copper and zinc and a little potash and soda. This suggests the corrosion of iron and brass by fatty acids—probably soft soap had been occasionally used as a lubricant.

While pursuing inquiries into the causes of firing and explosions in compressors, the following additions to the Mines and Works Regulations are proposed to endeavor to prevent this class of accident:

(2) All compressed air receivers and their connections to air cylinders shall be kept clean and free from carbonized oil or other material liable to ignition, and shall be opened and examined in this respect, by the resident me-

chanical engineer appointed under Regulation No. ...... or other duly authorized and competent person at intervals not exceeding one month. A written record of each such inspection signed by the person making it, who shall be held responsible for compliance with this regulation, shall be in the user's possession and open to inspection by the Inspector of Machinery.

(3) Thermometers or pyrometers, the indications of which can be clearly read, shall be fitted close to the outlet valves on the discharge pipes from the cylinders of air compressors. The highest temperature allowed shall be indicated by a red mark on the scale, and the engine-driver in charge shall be responsible that this temperature is not exceeded.

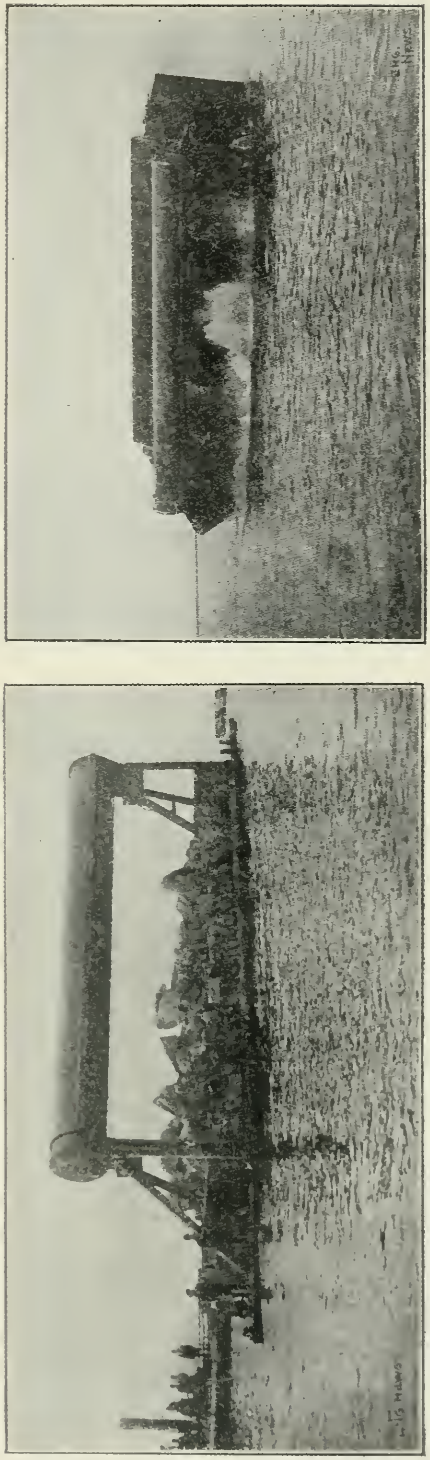
AIR OPERATED SELF-DUMPING SCOW

The half tones and cuts, which we here reproduce from *Engineering News,* give us a clear idea of the construction and operation of an ingenious self-dumping scow or barge which has been successfully employed in Sweden, and which seems destined to make for itself a wide field of usefulness. The description which follows is by the inventor, Mr. A. F. Wiking, of Stockholm, Sweden.

The problem of dumping stone and dirt into the water is particularly of interest in Stockholm, where blasting goes on all the time in the work on extensions of the harbor and streets. A good many designs for automatic dumping barges have been suggested, but none has come to a trial except the one hereby presented. Of course the common hopper barges with doors in the bottom have been largely used.

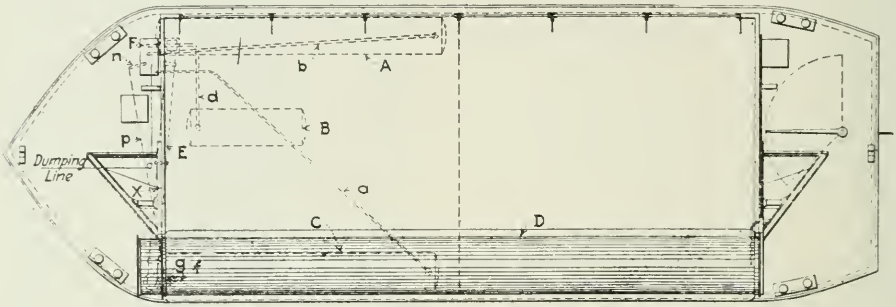
The accompanying figures show a new type of barge designed by the writer. The mode of dumping is new, so far as the writer is aware, and has had its natural development on account of the large quantities of rocks which must be dumped in the waters about Stockholm. The common hopper barges with flaps in the bottom have not proved suitable for this particular work. The city authorities, therefore, up to this time, have exclusively used barges with ridged decks and flaps along the side. The dumping has been by hand power, though helped by inclination of decks.

When the design shown in the accompanying figures was fabricated in steel and tested, it

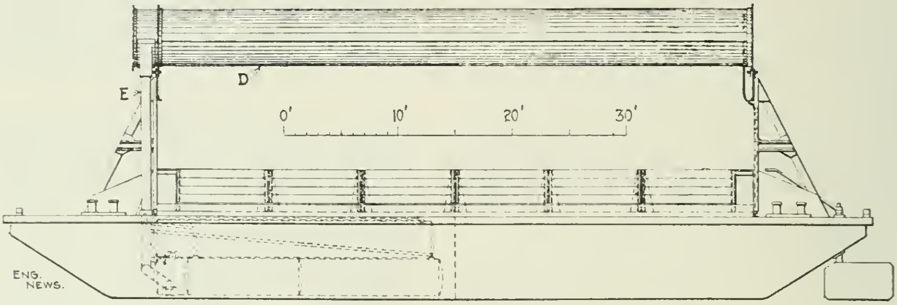

SCOW LOADED.
FIG. 1.
SCOW DUMPED.

worked so successfuly that no alterations whatever were necessary.

The barge has taken on a load of 200 to 220 tons and dumped it without any hitch whatever, and is doing so continually. It takes twice as much load as the ridge-deck barges, costs only 3-5 as much as two such barges and saves the wages of 6 to 8 laborers. Of course, if the load was gravel or material suitable for the common hopper barges, the saving in working would not be as large as above. In such a case, however, one has to reckon with a much larger initial cost for hopper barges and with heavier outlay for maintenance. In this new barge the hull is not exposed to the attack of the cargo, which is delivered on a flat deck of ample dimensions. The deck is protected by a timber flooring which is easily and cheaply replaced.



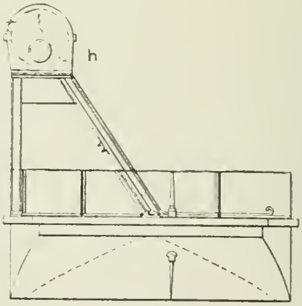
Deck Plan.



Side Elevation.

FIG. 2.

Fig. 2 shows the general features and lines of the design. Fig. 3 is a cross-section of the hull. The operation is as follows: The tank "A" is filled with water (about 6 tons, for a deck of 200 tons, in the actual design shown). The tank "B" contains compressed air at about seven atmospheres pressure. The tank "C" is at first empty but open to the air through the pipe "a." The tank "A" is in open communication with the upper cylinder "D" by the pipe "E." The tank "A" is also connected by an air pipe "b" to a valve box "F." The compressed-air tank "B" is connected to the valve box by the air pipe "d." While the tank "C" is always open to the free air through the pipe "a," yet it connects by the pipe "f" and valve "g" to the main pipe "E" going from the water tank "A" to the elevated tank "D." The tank "D," it will be seen, is always in open communication with the water tank "A" and with the atmosphere by the pipe "h."



End Elevation

The valve box contains a slide-valve mechanism which may be given four successive arrangements by successive pulls on a small line running from the barge to the towing vessel. These operations of the valve mechanism change the weight distribution on the barge so that it is dumped and returned to normal position merely by pulls on the dumping line.

The load is placed on deck, which has bulwarks on three sides. The fourth side (that one below the cylinder "D") must have only a low ridge "k"—Fig. 3, or doors to be opened by the pressure from the load on the inclined deck. For loads of rocks even the ridge is not wanted—a smooth deck is needed.

After the barge is loaded and towed to the dumping place, the operating line is carried over to the towing vessel. By the first pull on the cord, compressed air is admitted to the tank "A" and the water is forced up into the cylinder "D," so that the barge losses its equilibrium. It then tips until the rocks slide off. A second pull on the cord shuts the supply of compressed air off from the tank "A" and connects the latter to the atmosphere.

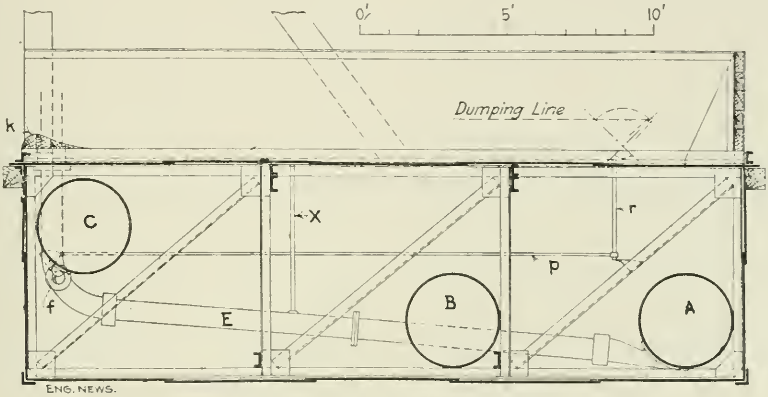


FIG. 3. CROSS SECTION OF HULL.

If the load slides off before the upper tank "D" reaches the water, then at the second pull on the operating cord the water drains from "D" back to the tank "A." If the tilting has been complete so that "A" is not lower than "D," then by a third pull on the cord the water in "D" is drained off to the intermediate tank "C," which is always lower than "D." To effect this the valve-box mechanism throws into gear the lever "m," shaft "r," lever "n," connecting rod "p" and the valve "g." The barge rises and soon is upright and the water in "C" (with any not drained from "D") flows back into the tank "A." A fourth pull on the cord restores the valve mechanism to its original position, as before the dumping. The pipe "X" is for sounding the liquid in tank "A." As none of this water ballast is lost in opening, glycerine is mixed with it to prevent freezing in cold weather.

Compressed air is fed to the tank "B" by a hose connection and shut-off valve at the valve box. About 2 cu. m. (71. cu. ft.) of compressed air are necessary for a single dumping The cost is small. Here it costs some 50 öre, or about 12 cts., if obtained from a shop installation for pneumatic tools. A small compressor, worked by an oil engine may be placed on one tug and used for all the barges of a fleet.

The illustration on page 5647 shows a barge delivered to the city of Stockholm, where it is in daily service.

In comparing this barge with the common hopper barges with false bottom it appears that it is cheaper in first cost and will be cheaper in maintenance, that it accommodates rocks of practically any size and weight within its total capacity, that it is a first class craft for any harbor transport.

A hospital for the workers on the Wallkill pressure tunnel, has been provided by the Degnon Contracting Company, to whom this contract was awarded. The building is located near Forest Glen, N. Y., and contains an operating room, dispensary, general ward, isolation ward, kitchen and servants' quarters, and quarters for a resident surgeon, who spends his entire time on the work.

CONSERVATION OF LIFE IN COAL MINES

At the Spokane meeting, September, 1909, of the American Institute of Mining Engineers, a notable paper on "The Conservation of Coal in the United States" was presented by Mr. Edward W. Parker, of the U. S. Geological Survey. Mr. W. L. Saunders, of New York, contributed to the discussion of the above paper, in part, as follows: Mr. Parker's paper, though entitled the Conservation of Coal, might also be called the Conservation of Life in Coal-Mines. That the casualties in the coal-mines of the United States should have exceeded 3,000 in the year 1907 is simply appalling, and that 1,000 men should have been killed in a single year through explosions alone, points to the importance of activity not only among mining engineers but also by the legislatures of the respective states.

There is but little doubt that nearly all the serious coal-mine explosions which have taken place in the United States during the past 10 years have been due to coal-dust alone, or to coal-dust and gas mixed, and that the ignition has been caused by blown-out shots. If, then, the blown-out shot is such a deadly agency, it is natural to ask whether or not it is preventable, and, if preventable, how? If the hole is drilled in the proper place to the proper depth, charged with the right amount of powder, and properly tamped or stemmed, a blown-out shot is an impossibility, providing, of course, the coal has been properly prepared for blasting. If, then, the application of ordinary skill and experience would eliminate this frightful danger, why is it not done? Because the modern mine-crews are largely made up of men who are inexperienced, unskillful, and densely ignorant. These men are allowed to drill their own holes and to charge and fire them, notwithstanding that the lives of all the men in the mine are depending on the good judgment of each individual man. At many places all the men have to be out of the mine before the shots are fired, and this dangerous work is performed by shot-firers. During 1907 12 shot-firers lost their lives by explosions in Illinois.

That State produces more than 40,000,000 tons of coal per annum, and in 1907, out of a little more than 40,000,000 tons mined, nearly 25,000,000 tons were blasted from the solid; the bill for powder amounted to $2,208,343, and represented 1,261,910 kegs. It is interesting to note that where the coal was undermined by machinery, each keg of powder produced 96.02 tons of coal, while from the solid each keg blasted only 25.78 tons.

WHAT IS A BLOWN-OUT SHOT?

Perhaps the simplest description of a blown-out shot is one that does no useful work in shattering or blowing-down the coal, but blows out its tamping and projects a long vivid tongue of flame into the chamber where it is fired, the floor and sides of which are usually covered with coal-dust. This coal-dust is raised in clouds by the concussion, in this diffused condition it is easily ignited, and an explosion occurs which goes through the mine with inconceivable rapidity, carrying with it death and destruction, the extent and violence depending on the amount of dust and of good air (oxygen) in the mine. If 1 or 2 per cent. of fire-damp (CH_4) is present in the air, the dust ignites more rapidly. Until recently it was a disputed question as to whether coal-dust could be exploded in the absence of fire-damp, but this question has been settled beyond controversy by physical tests which have been made, in which thousands of people have seen coal-dust without any admixture of gas exploded by using a cannon-shot to represent the blown-out shot, and an iron tube 100 ft. long and 6 ft. in diameter to represent a mine gallery. Coal-dust is strewn on the bottom and on shelves along the sides, the cannon loaded with black powder and stemmed with fire-clay is fired into the tube, and a terrific explosion occurs.

It also has been demonstrated by this method that there are many explosives which do not ignite coal-dust as readily as black powder, on account of the very much shorter flame produced, and these are consequently much safer to use in mines; but as no explosive is flameless, this does not promise perfect immunity.

PROPERLY PREPARING THE COAL.

A blown-out shot occurs when the tamping is the path of the least resistance. This is likely to happen when the hole is drilled beyond the undermining, or when it is drilled on the rib, away from the undermining, or where blasting from the solid is practiced entirely. In some cases it is the result of carelessness; in many the result of ignorance; in some of neither, but of improper preparation of the coal. In thick seams, where the undermining is done with chain-machines, where the undercut is 6 or 7 ft. deep and 4 in. high, the hole is generally drilled in the rib at such an inclination that it will touch or nearly touch the roof at the back. In this case the coal is not properly prepared; it is almost as bad as blasting off the solid, in some cases worse, for the way the hole is drilled makes it more dangerous. Many of the most disatrous explosions have occurred exactly under these conditions. The most destructive colliery-explosions which have occurred in recent years have been caused by blown-out shots, where the coal has been mined with chain-machines. Harwick, Monongah, Darr, and Marianna are notable examples. In these four explosions nearly 1,000 lives were lost.

The truth is, that undermining coal is not a sufficient preparation for blasting; it should be sheared on one side or in the middle. In this condition less than one-half the powder would be necessary, and less than one-half of the smoke would result, giving better sanitary conditions, and less danger of falling roof, which is a prolific cause of injury and death. All the coal would be in a better condition for handling and rehandling, giving much less slack at destination, and a positive gain of at least 20 per cent. more lump.

The value of shearing in the preparation of coal is recognized by mining engineers, mine-superintendents, and mine-foremen, as well as by coal-oeprators; but because they think it adds to the cost of production, they are willing to forego the advantages. It would add little, if any, to the cost of coal, for when lump coal is worth from $1 to $1.40 per ton and slack is worth from 20 to 40 cents per ton at the mines, while shearing will increase the more valuable coal by 20 per cent., and the cost of shearing with approved shearing-machines, would be about 6 cents per ton, it is not hard to figure what is would cost.

FALLING ROOF.

Shearing will be universal some day, and it will be a blessing to the workman and to the operator, and to all interested in the conservation of our national fuel-supply.

It is likely that in a comparatively few years the vast bulk of our bituminous coal will be produced without explosives of any kind; it will be excavated and loaded by mechanical means entirely, reducing explosives to a disappearing minimum, and so reducing accidents by falls of roof that a death through this cause will be as rare as it is now frequent.

A great many more deaths result from falling roof and coal than from all other causes combined, but little notice is taken of them because the fatalities occur only one or two at a time, and are scattered all over the coal-regions. This great loss and waste of life should not be less appalling because there is nothing spectacular about it. The sorrow and suffering are just as acute, there are just as many widows and orphans, just as many bereaved fathers and mothers, as if the lives were lost in explosions, and just as earnest efforts should be made to prevent deaths from this cause as from any other. It is easy to say that in most cases it is carelessness or ignorance, or both; but this does not relieve us from responsibility, especially if ignorance is the cause, for if we employ workmen who are ignorant it is our duty to teach them, and so to safeguard their lives that they shall not lose them through ignorance. Fully 95 per cent. of all fatal and non-fatal accidents caused by falling slate or coal take place in the working-faces where the miners are engaged in digging or loading the coal. In some mines the roof is naturally bad, and should be carefully and systematically timbered, the props having over them stout, broad cap-pieces, presenting a wide surface to the roof and set at near the face as necessity may demand. If this is done the miner can work between the props with perfect safety; but as he looks on this work as being unproductive, he will not take the time, or he may feel indolent and neglect to make his working-place safe. To overcome this, there must be stringent rules compelling systematic timbering after an approved method, which would make all working-places safe. One of the most prolific causes of falls of rock and slate in the faces is blasting, especially where the coal is undermined by chain-machines, or where blasting off the solid is practiced, as exceptionally large shots are necessary. These shots jar to such an extent that the roof, which before was comparatively safe, becomes loose and dangerous, and too often the miner goes into a place which has been thus rendered unsafe and commences to load coal under a roof which may come down, and which frequently does come down, maiming him or crushing out his life. At least 75 per cent. of these accidents can be avoided if the mine-managements adopt proper methods which are rigidly enforced. As already indicated, one method is in systematic timbering; if in addition to this all blasting from the solid is made a criminal offense, and blasting is permitted only when the coal has been undermined and sheared on one side, then the roof would sustain but little, if any, injury from powder-shocks. If this precaution were observed, and a man were employed to visit each place once (or, if necessary, twice) a day, making sure that all the rules are enforced, deaths by falling roof would be rare, instead of daily, occurences. In the North of England one man, who is called a Deputy, is employed for every 20 or 30 men. His business is to look after their safety, to visit every place as often as necessary, each shift, to see that each place is amply supplied with timber of proper length, and in cases of peculiar danger to set it himself; he carries an axe and saw, and is always ready for emergencies. These miners are to the manner born; they come of long generations of miners, and in all the world there are none more skillful or intelligent, all speaking a common language. If it is necessary to throw such safeguards around them, how much more necessary it is where we have such a lack of skill, such dense ignorance, and so much difficulty in oral communication.

MANUFACTURE OF LIQUID AIR

It is stated that in his pioneer experiments in mechanical flight Langley employed a small steam engine, but that the water required for a five minutes run exceeded the weight of the engine itself, and in addition to that there was the steam generator and the fuel. Later developments with internal combustion motors have improved vastly upon that, but the reduction of weight of water and appurtenances is still the problem of extended or continuous flight.

Many amateurs are working upon model aeroplanes with sometimes interesting results. One writer in *The Model Engineer and Electrician* wishing to store as much energy as possible and to keep down the weight of the container has tried liquid air. The advantages, as he reasoned it, are—that a given weight of air occupies in its liquid state only one eight hundredth of its normal volume, and because it was only necessary to keep the reservoir at the working pressure it could be kept comparatively light. One reservoir was built of tinplate, with dished ends sweated together, and as it was well made, it was frequently worked at 150 lbs. per sq. in. pressure. The liquid air was poured in an opening, which was afterwards closed by a piston safety valve. The heat, which passed in through the container, caused the liquid to boil, and the air passed through an aluminum tube, which was coiled twice round the reservoir to the engine. The air was able to get away through the engine, so the pressure was kept low—indeed, it was only about 30 lbs. per sq. in. The reservoir was then fitted with a very thin aluminum casing, which carried two or three sponges, soaked in methylated spirits, at one end. The spirit was lit, and as the boiler was placed in the draught from the propeller, a blast flame played along the boiler and on the coils through which the air passed to the engine.

Having dealt with the objects for using the liquid air in this case, it is now intended to describe a small plant for its manufacture. But it should be clearly understood that the proposal to use liquefied gases for generating power is absurd, except in a special case like that described above, in which the cost was a secondary consideration.

Air must be reduced to a definite low temperature in order to liquefy it, because above this point no pressure, however large, will suffice. If it be reduced to another—lower—definite temperature, it becomes liquid at the ordinary atmospheric pressure. It is then in the state in which it is kept in storage. At any given temperature between these two there is a definite pressure which will liquefy the air. In practice the air is compressed to about 180 atmospheres, and is cooled to a temperature near that of liquid air. When in this condition it is allowed to expand through a small orifice, and the sudden expansion cools the air still further, so that part of it is liquefied.

The apparatus described is known as the Hampson type air-liquefier, and produces about 1 1-3 litres (say quarts) of liquid per hour. A diagram of the general arrangement of the apparatus is given in Fig. 1. It is necessary to free the air from moisture and carbonic acid, because at the lower temperatures attained, these become solid, and, if present, choke the apparatus, especially the small orifice which has been mentioned, which is a needle valve, and the valve spindles and screws. The air is drawn through a low-pressure purifier, which contains slaked lime, by which carbonic acid is absorbed. From the purifier the air passes through a large tube to the compressor, from which it is delivered at from 150 to 200 atmospheres. The compressor cylinders are lubricated with water, and consequently some moisture is carried over in the compressed air. A separator is therefore provided, after the compression, to collect most of the water mixed with the air. As a final precaution the gas passes through a steel bottle charged with caustic potash, in which all remaining traces of moisture and carbonic acid are absorbed. The air next passes through the liquefier, in which it is first cooled, and then allowed to expand through a small orifice. A part of the air is liquefied, and the remainder, which is at a temperature almost as low as that of the liquid air, passes around the coils which convey the compressed air to the orifice. The exhaust is connected to the low pressure purifier, because this air has been purified, and by using it again, with fresh air only as the make-up, the charges in the purifiers are found to last for a considerable time.

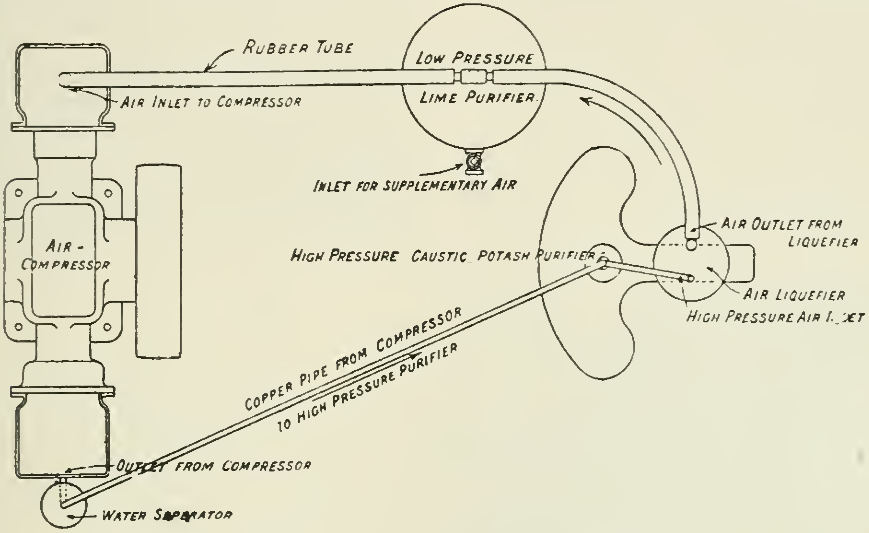


FIG. 1. GENERAL PLAN OF AIR LIQUEFYING APPARATUS.

The low pressure purifier is a galvanized iron cylinder, with an outside through connection to allow the exhaust air from the liquefier to pass direct to the compressor. There is a cock at the bottom of the cylinder to regulate the supplementary air, which replaces the air that is liquefied. This make-up air passes over the lime, which is supported on trays, and joins the liquefier exhaust at the tee-piece at the top of the purifier. The mixed air passes to the compressor through a large rubber tube.

THE WHITEHEAD COMPRESSOR.

The compressor illustrated in Fig. 2 is of the Whitehead type. It is here shown belt-driven, but it is also made direct coupled to an electromotor. It is capable of compressing 550 cu. ft. of air per hour to a pressure of 200 atmospheres, running at 400 r. p. m., and then requiring 6 h. p. to drive it. The compression is two-stage, the cylinders being opposite each other, and the crank between operating both pistons. The cylinders are surrounded by water contained in troughs bolted to the main casting. The air when compressed in the low pressure cylinder passes through a coil of tube which encloses the cylinder and is immersed in the water jacket. The air is thus brought down to the water temperature before entering the high pressure cylinder. After compression it passes through another cooling coil in the outlet pipe.

The relief valve on the high pressure cylinder is a very important feature, because the valves occasionally stick, usually on account of the fiber washers breaking, and warning is then given by this safety valve blowing off at each stroke with sounds like rapid pistol shots.

The compressed air passes through the separator and the purifier, both of the simplest construction, to the liquefier.

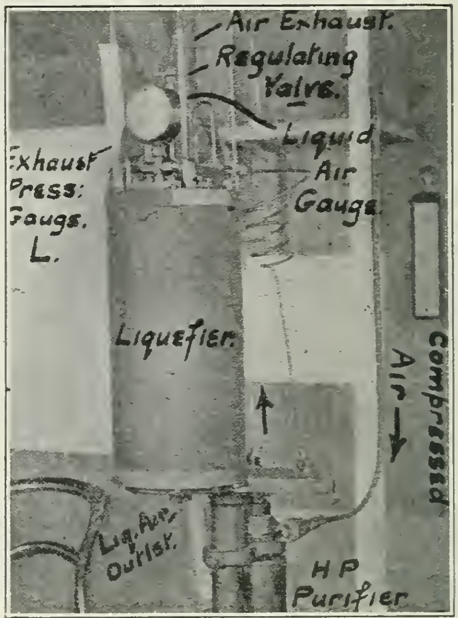


FIG. 3. SEPARATOR AND PURIFIER.

This is shown in the half tone, Fig. 3, and the vertical section, Fig. 4. The air passes down through the coils *B*, and is allowed to escape through valve *C*, which is regulated by a hollow spindle *D*, to which a hand wheel *E* is attached on the top of the apparatus. The compressor is started to work with all valves open, including the expansion valve *C* and the liquid air discharge valve P. The air is allowed to blow through for a short time to dry the coils. The valve *P* is then closed, and the expansion valve *C* is closed, or nearly so, to allow the compressor to raise the pressure to about 180 atmospheres. The moisture which collects in the water separator is blown off at intervals of five minutes whilst the compressor is working, a valve being provided for this purpose. When the required pressure is attained, the valve *C* is slowly opened until from 6 to 8 cub. ft. per minute pass through the liqefier. This is adjusted by reference to a glycerine gauge *L*, which records the pressure at the outlet. The efficiency of the plant appears to be very nearly constant over a fairly wide range of inlet pressure and rate of flow, as indicated by the glycerine gauge. The air expands to nearly atmospheric pressure on passing the valve *C*, and its temperature falls. The cold air passes back over the regenerator coils *B*, and the compressed air approaching the expansion valve becomes steadily colder for about ten minutes, when part of the air commences to liquefy and collect in the receiver *G*. The apparatus has then almost reached its steady working state, and liquid air may be collected at the rate of a bottle (1 1-3 litres) per hour.

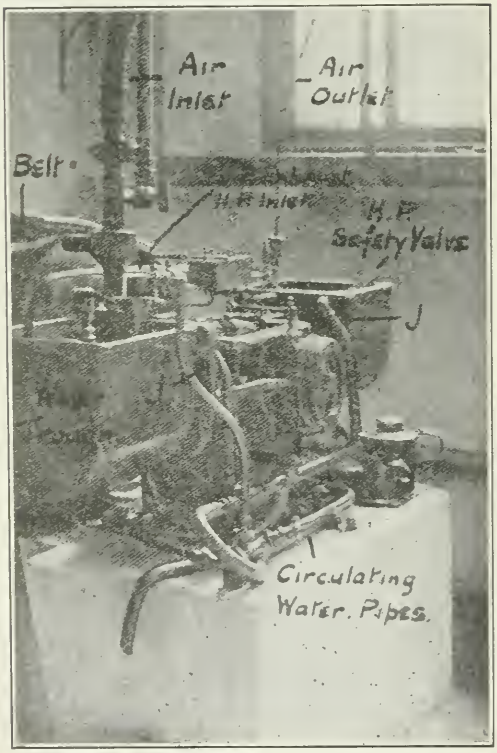
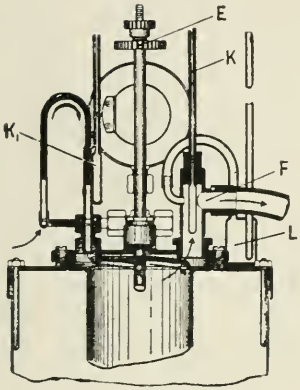


FIG. 2. WHITEHEAD TYPE AIR COMPRESSOR.

When the expansion valve is closed, and the compressor is working to raise the pressure, the thermometer plug at *K* is taken out to prevent air being sucked through the glycerine gauge *L*, because no exhaust air is then passing over to the compressor. It is also necessary to frequently move the valves *C* and *P* when the apparatus is cooling down, because, even if the air be pure, so that the valves do not freeze up, the unequal contraction might fasten them.

The liquid air is drawn off at intervals of about 5 minutes, or when about 100 cc. have collected. This is indicated by the colored water in the



PART SECTIONAL VIEW OF TOP.

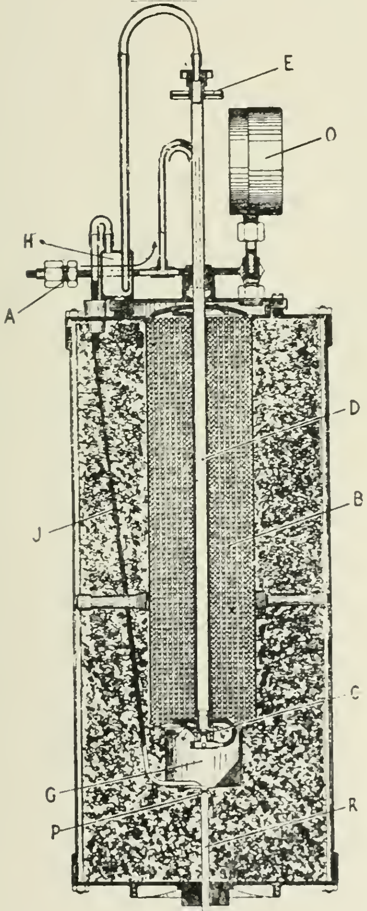


FIG. 4.—FULL LENGTH SECTIONAL VIEW OF AIR LIQUEFIER.

gauge *H*. This gauge is in communication with the receiver through the pipe *J*, and the hollow spindle *D* of the expansion valve *C*. When liquid air collects in the receiver *G* it compresses the air in the pipe *J*, and so displaces the coloured water in the gauge *H*, causing it to rise in the vertical indicating tube. Liquid air is drawn off through the hollow spindle *R* by turning the wheel *T*, and thus opening the valve *P*.

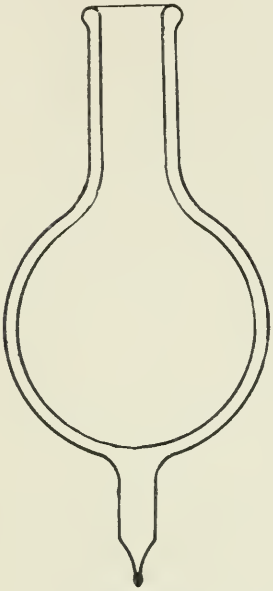


FIG. 5*a*.

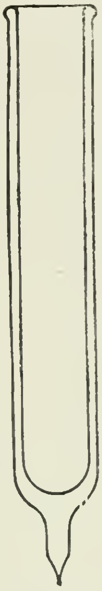


FIG. 5*b*.

Before closing down, when there is still some pressure in the apparatus, a valve at the bottom of the high-pressure purifier is slightly opened to blow out the collected water with its dissolved caustic potash.

The liquid air is collected and stored in a glass vessel illustrated in Fig. 5*a*. It consists of a double walled flask, and the air is extracted from the space between the walls. Sometimes a little cocoanut charcoal is placed in this space, because it absorbs the residual air when it is cooled by the liquid air. The vacuum prevents heat passing into the liquid, which would cause it to boil away, and the walls of the vessel are silvered with a similar object. Demonstration vessels are also made of the shape shown in Fig. 5*b*, and these are supplied either silvered or not. It takes about seven days for a full litre bottle of liquid air to completely vaporize away. Liquid air may be bought in many of the large towns of Great Britain.

THE EFFICIENCY OF COMPRESSED AIR

By SNOWDEN B. REDFIELD.

"What is tthe ratio of the work represented in the compressed air to that done by the compressor?" This is a question often asked and it is a difficult one to answer clearly.

It is fairly well known that the energy transformation in the use of compressed air is not high, but the fact that it "does things," some of them better than by any other means and some which are not done by any other means at all, makes the matter of fuel economy of secondary importance. No apology is needed for the use of compressed air to-day.

That this matter of the fuel economy is not well understood is evidenced by the repeated appearance of propositions to develop the power of a water fall in the form of compressed air and transmit this through pipes to some distant point where its energy, like that of electricity, is supposed to be turned back again into work.

Such power transmission propositions as this are absurd, because the losses in the compression and expansion of the air reduce the power efficiency to too low a point. These losses are not losses of pressure by friction, nor air by leakage, but losses due to heating and cooling.

It is not a difficult matter to prove that all of the work of compression goes into heat and is lost in pipe-line radiation. All of the work performed at the far end comes from the intrinsic heat originally in the air, and the economy obtained depends entirely upon how the air is used. The actual cold compressed air traveling in the pipe does not at all represent the energy put into it by the compressor, as this has all been lost in radiation, and the only answer to the question first propounded, is: "Nothing."

However, we all know that the air does work, and this may be compared to the compressor work (although they have no direct relation) and in this way an "efficiency" may be stated.

In almost all cases compressed air is used in some form of reciprocating cylinder without expansion; indeed if expansion were allowed (unless reheating is resorted to) while the air could then give up more work, the moisture always present in the air would quickly freeze, choking the exhaust ports and passages of the machine with ice.

As examples of machines using air with little or no expansion, rock drills and pneumatic tools may be cited, and some interesting figures as to the efficiency of the power transformation, are given by the accompanying diagrams.

While actually indicating the drill or tool cylinder would be difficult, some rough idea of the indicated horsepower developed within it may be obtained by a little figuring, together with some judicious guessing.

Indicator diagrams of such machines would theoretically be rectangles, but wire drawing and cushioning effects of the valve mechanism would considerably modify this. It may be assumed then, reasoning from such a thing as a steam pump cylinder, without cutoff, that the diagram factor will be about 80 per cent. In other words the actual mean effective pressure will be about 80 per cent. of what the theoretical rectangular diagram would give.

On this basis it is determined that a standard rock drill having a 3-inch diameter cylinder will develop about 6.2 indicated horsepower with 100 pounds at the throttle, this decreasing with the pressure supplied, down to about 3.7 indicated horsepower, with only 60 pounds pressure.

A 3-inch rock drill will require about 138 cubic feet of free air per minute with 100 pounds pressure at the throttle; this decreasing to 90 cubic feet, with only 60 pounds pressure.

Knowing the quantity of air and the pressure, the compressor horsepower is easily calculated.

Thus, allowing 10 pounds pressure drop in the pipe, a 3-inch rock drill will require 29.8 indicated horsepower in the steam cylinders of the compressor with 100 pounds pressure and single-stage compression, or 25.2 indicated horse-power with compound compression. These figures reduce as the pressure used is reduced, but this, of course, reduces the work done by the tool.

Comparing the probable indicated horse-power developed inside the drill cylinder with the actual compressor power required to furnish the air, gives the probable efficiencies shown by the chart. These efficiencies are referred to both the air and steam cylinders of the compressor, so as to give a basis for calculations for various methods of driving the compressor. They include 10 pounds pressure drop in the pipe line.

Referred to the air end of the compressor, it is thus seen that with single stage compression and 100 pounds pressure, about 23.5 per cent. efficiency is obtained, increasing to about 29 per cent. with the low pressure of 60 pounds. Compound air compression brings these figures up to 27.8 per cent. with 100 pounds and 31 per cent. with 70 pounds.

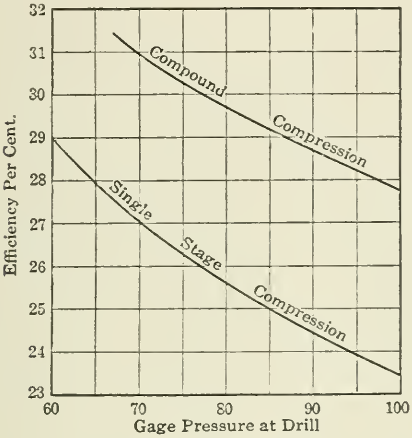
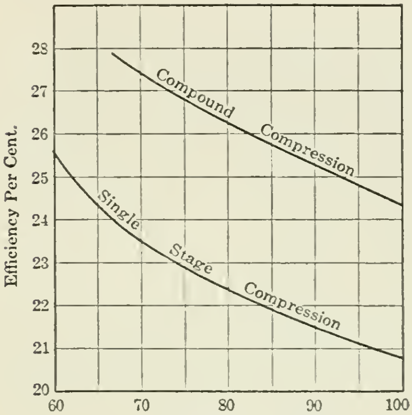


FIG. 1. PROBABLE EFFICIENCY REFERRED TO AIR END OF COMPRESSOR

Referred to the steam end, allowing 88 per cent. mechanical efficiency between the steam and air ends of the compressor, single-stage compression gives a little less than 21 per cent. efficiency with 100 pounds and about 25.5 per cent. with 60 pounds air pressure. Compounding the air cylinders of the compressor increases these figures to about 24.5 per cent. with 100 pounds and almost 27½ per cent. with 70 pounds air pressure.

While these figures for efficiency have been determined for rock drills in particular, they apply equally well to almost any machine using compressed air without expansion. It must, however, be remembered that the figures are based upon indicated horsepower only, both in the drill and the compressor. This is because of the impracticability of measuring the "brake horsepower" of the drill. If, however, brake horsepower efficiency is required, these figures for efficiencies of indicated horsepower can be multiplied by the mechanical efficiency of the device using the air, say 90 per cent. or 80 per cent., as the case may be. This, of course, gives a still smaller result.

It is to be noted that the higher efficiencies are obtained with the lower pressures. This is because there is less loss by heating the air during compression, and therefore it is advisable to use pressures as low as is consistent with the size and weight of the machine required to do a given amount of work.—*American Machinist.*



American Machinist

FIG. 2. PROBABLE EFFICIENCY REFERRED TO STEAM END OF COMPRESSOR

EXCESSIVE VENTILATION MAKES A DRY AND DUSTY MINE

"An Engineer and Mine Manager," name and address not given, writes as follows in *Mines and Minerals:*

A prominent English mining authority says (I quote from memory): "No mine is well ventilated that has less than 1,000 cubic feet of air per man per minute circulating through its workings." The term, "well ventilated," is certainly only relative. It is easy to believe that 1,000 cubic feet of air per man per minute would not be excessive in some mines that generate large quantities of explosive gas; but what is the effect in a mine in which explosive gas is not generated in sufficient quantities to be detected, or in a mine which generates very little explosive gas? Would not the amount of air called for by the above rule add to a non-gaseous mine a marked factor of danger?

This vast volume sweeping through the entries and workings in the winter time would absorb an appreciable amount of the natural moisture of the mine and might change a damp mine into a dry and dusty one. It would also distribute the coal dust widely, and keep it stirred up, and if there happened to be a windy shot or an accidental ignition of powder, a dust explosion of magnitude might be the result.

It has taken a long time to educate the managers of some mines to equip them with ventilating apparatus which will furnish more than barely the legal quantity of air to the workings, but has not their education been overdone in the past few years, and are not the managers and engineers of large mining operations now going to the other extreme? Are they not putting too much air into some of their mines and thereby increasing the liability of dust explosions in the winter months by drying them out with an unnecessarily large ventilating current?

Consider for example a mine generating in one portion a small amount of explosive gas and having, say 500 inside employes. The Pennsylvania law requires for this mine a minimum of 150 cubic feet of air per minute, or 75,000 cubic feet of air in circulation. At the present time the management would probably provide, to be on the safe side, from 150,000 to 300,000 cubic feet per minute. Assume that the amount of air in circulation is 200,000 cubic feet per minute, which would for a considerable time during the winter months in Pennsylvania, enter the mine at a temperature of say +22° F., and also that the intake air is fully saturated with moisture and that the temperature of the mine is +62° F.; assume further that the ventilating current before it is discharged from the mine will absorb moisture until it is 90 per cent. saturated; in this case the ventilating current is removing moisture or water from the mine at a rate of 840 gallons per hour or 85 net tons per 24 hours. This drying out of the mine must materially increase the extent and destructiveness of an explosion, should one occur, particularly if the mined-out area is comparatively small. There is such an excessive quantity of air flowing through the mine that there is no danger of a gas explosion, provided the air is properly distributed, but has not the mine been rendered more dangerous by this drying out?

The only way to keep a dry and dusty mine safe is by the removal of the carbonaceous dust and then dampening with water or by distributing chemicals which have great affinity for water. Under the best of conditions, it is practically imposible to remove all of the dust and to saturate thoroughly all parts of the mine. It requires such constant and conscientious work to remove the dust or thoroughly to dampen it that, without the utmost vigilance, portions of the mine are apt to be slighted. Under no circumstances would a competent person suggest that the volume of the air circulating in a real gassy mine be reduced to save the natural moisture, but there is no question that in many mines, including some that are classified as gassy under the law of Pennsylvania, excessive ventilation increases the liability of explosions. Is it not a question of balancing these factors?

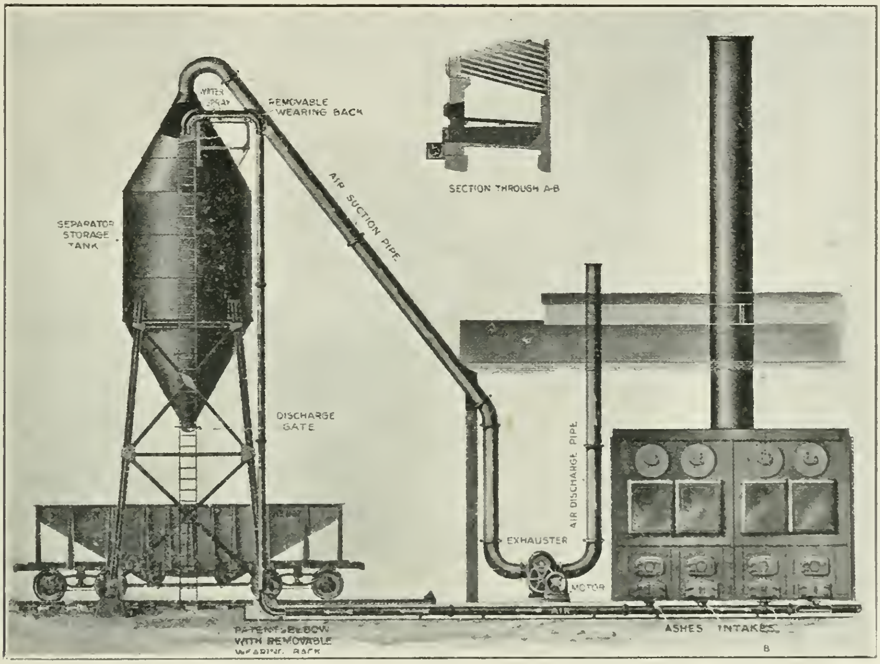
In some quarters, the above will be called rank heresy, but the entire trend of the late experiments and the conclusions reached by the best thinkers is that the drying out of some mines in the winter months by excessive ventilating creates a greater danger than would result from less ventilation.

In a number of mines in Pennsylvania, where a force fan is used for ventilation, the exhaust steam from the engines has been turned into the downcast with marked benefit to that portion of the workings first reached by the air. The result is that the air is heated quickly and the moisture of the steam is at the place ready to be absorbed into the air-current, or in other words, there is a certain amount of moisture put into the mine by the steam which is immediately absorbed by the air and, consequently, much less moisture is removed from the mine. If this plan were adopted and then supplemented by a number of fine sprays discharging water into the air at different places, until the air when it reached the tempreature of the mine is as nearly saturated as possible, there would be no more liability of mine explosions in winter than in summer.

In the tunnel through Bergen Hill, New Jersey, a No. 34 Slugger drill, with air at 90 lb., drilling hard diabase, which has a specific gravity of 2.98, was found to average 1 ft. of hole per hour. The rock was very "blocky," causing the drills to bind and stick badly. In normal trap the speed of drilling under like conditions is 1 ft. in 20 to 25 minutes.

A PNEUMATIC ASH ELEVATOR AND CONVEYOR

In any large boiler plant the removal of the ashes is an important item to be provided for, and it is no longer to be thought of as a thing to be done by hand. Traveling conveyors have been quite satisfactory for the purpose until the present when we may expect pneumatic apparatus to generally supersede them. The half tone shows the essential features of the pneumatic, or, rather, the suction ash conveyor system of the Darley Engineering Company, Singer Building, New York City. The arrangement of the details of course varies according to circumstances.



PNEUMATIC ASH ELEVATOR AND CONVEYOR.

Along the back or the front of the boiler battery—according to the arrangement of the boilers and ashpits—is run a horizontal pipe, which has a top inlet in front of each ashpit. These inlets are closed with stoppers, but when any ashpit is to be cleaned the stopper of the inlet is removed and the spout of a portable hopper is inserted, the ashes are then raked out into the hopper and fall into the pipe. The far end of the pipe is open to the atmosphere. The delivery end is continued horizontally and vertically to discharge into the top of an ash storage tank or bin, which may be of steel or concrete construction. At the discharge of the pipe is a water spray, which serves to cool the clinkers and wet down the dust. The vertical lift may be as high as 120 ft.

From the top of the ash tank a 22 in. suction pipe is led to a blower of the runner type, from which a delivery pipe is carried to the chimney. Centrifugal exhausters have been found less satisfactory than others. On the suction pipe, near the tank, may be an expansion chamber. The ashes in the tank are delivered through bottom spouts into carts or railway cars.

The conveyor pipe from the ashpit to the tank is from 6 in. to 10 in. diameter, and has 6 in. inlet openings. Large clinkers are broken by a shovel or bar as they are raked out. The pipe may be laid above or underground, as may best meet the conditions in each case. At all bends in the pipe there is, of course, liability of severe wear by the cutting and abrasion of the fine hard particles. This is provided for by using split elbow castings having an inserted wearing back of hard cast iron about 3 in. thick. These will last for from ten to eighteen months. In one case right-angle turns have been used, the end opposed to the stream being closed by a cast iron plug, which is easily renewable.

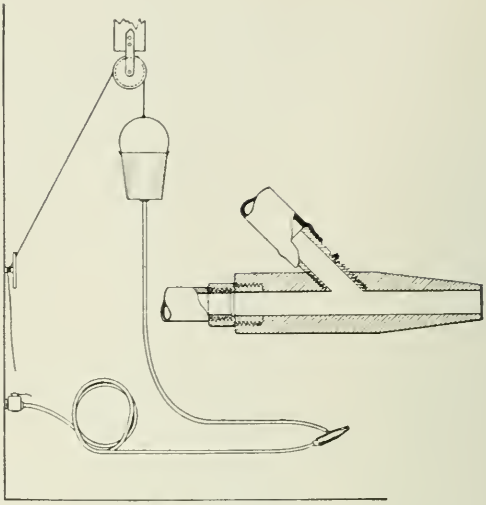
The main blast of air enters at the open end of the pipe, comparatively little being taken in at the ash inlets. Two or more inlets may be open at one time, but, as a rule, there is only one man to attend to cleaning the ashpits, so that only one inlet is open. The delivery of the ashes is from 200 to 500 lb. per minute, and they are best handled when dry, being wetted down only as they enter the tank. The suction pressure is from 16 to 32 ounces at the exhauster, and may drop to 4 oz. at the end of a long pipe. In a plant of 6,000 boiler H. P. one man on each shift takes care of the ashes, while formerly eight men were required on each shift to remove the ashes by hand. At another plant, the firemen clean the ashpits four times in twenty-four hours, and can dispose of all the ashes in 15 to 20 minutes at each cleaning.

The repair and renewal work is extremely small, and—contrary to first expectation—the conveyor pipes do not wear out. This is due to the fact that the tendency is for the material to be carried in suspension in the middle of the pipe, instead of travelling along the bottom. The system is being applied also to the conveying of coal.

A HOME-MADE SAND BLAST

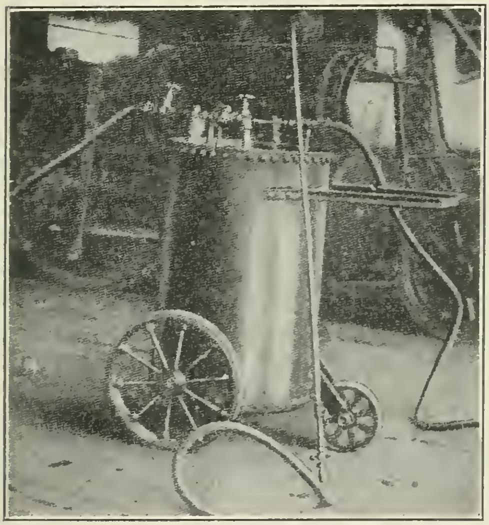
By Frank Rose.

A novel sand-blast rig is in use at our shop and for a home-made device it is doing good work. We had a large number of castings, which had to be smoothed up nicely inside and, owing to their irregular shape, it was quite a problem to do the job as the specifications called for. Various methods were tried without success. Finally one of the men suggested buying a sand-blast outfit, but as we had compressed air and lots of sand handy, and were a little bit pressed for time, the foreman decided to let the man make his own sand blast rig. He took a piece of stock bronze about 2 ins. in diameter by 8 ins. long and, after turning one end down for a nozzle, drilled a small hole through the center of the piece from end to end. Another hole was drilled from one side, joining the center hole at an angle of 45 degrees, as shown in the sketch. At the end a nipple was screwed in and fitted to a copper pipe, which had three or four coils in it. This pipe was fitted to the main air pipe through a hand valve. The coils in the pipe were for convenience in handling the contrivance by giving it flexibility, so it could be moved in any desired direction. Another nipple was fitted at the side and to this was connected a rubber hose, which led to the bottom of an ordinary galvanized iron pail. Another nipple had been fitted in the bottom of this pail and the end of the rubber tube was attached to it as shown. The pail was filled with sand and by means of a rope attached to the handle, the pail was hoisted to a height of about 15 ft. and then gravity and the suction created by the compressed air rushing past the mouth of the rubber tube sent the sand out of the nozzle with sufficient force to clean up the surface upon which it was projected. Now an apprentice boy is regularly employed running the sand blast machine, which has been found to give excellent results.—*Modern Machinery.*

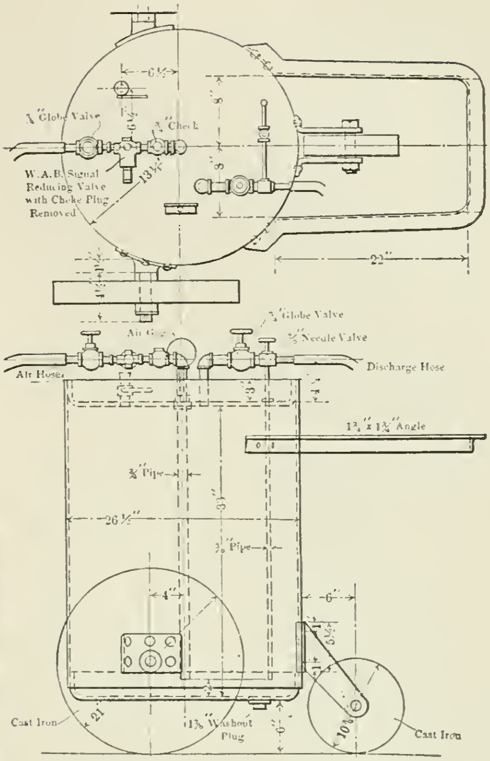

HOME-MADE SAND BLAST.

A LOCOMOTIVE FIRING-UP MACHINE

Starting the coal fires in locomotive fire-boxes by the use of crude oil is becoming quite general. This is usually done by soaking waste in oil and throwing it in on top of a light layer of coal in the firebox or by pouring the oil on top of the coal direct and lighting it. Either of these methods requires the use of considerable oil, and for the purpose of reducing this consumption, and also for reducing the time for igniting the coal in the firebox, a machine is in use at the Ashtabula engine house of the Lake Shore & Michigan Southern Railway, which is shown here in two illustrations. This consists of a large tank, mounted on wheels to be easily transportable around the house, which is filled with crude oil. Air pressure is carried to the bottom of the tank through a ¾-in. pipe and the mixture of air and oil is forced out through a discharge hose, the main connection being made at the top of the tank; this is supplemented by a connection through a ⅜-in pipe which extends to the bottom of the tank and connects into the discharge line through a needle valve. This mixture of air and crude oil is then carried through a long flexible hose at the other end of which is connected a small pipe of a length which will reach to the front end of the firebox, the man handling it being on the deck plate. The end of this pipe has a small T and a number of small openings, and the air and oil mixture under pressure, discharging at the end is ignited and, being swept over the shallow bed of coal on top of the grate, quickly ignites it in all parts. About five minutes' work with this machine will start a glowing fire over the whole section of a large grate with the use of about one-half of the oil that would otherwise be required, and in less than one-quarter of the time.—*Am. Eng'r and R. R. Journal.*



LOCOMOTIVE FIRE LIGHTER.



PLAN AND ELEVATION OF LIGHTER.

IRON MINES OF NEWFOUNDLAND

What the gold reefs of Johannesburg are to the Transvaal the Wabana iron beds are to Newfoundland. They form immense deposits of rich red hematite ore, three miles long and several hundred feet wide, and showing 34,000,000 tons in sight above the water. The beds dip downward at an angle of 8 degs., and it is believed that they extend below the sea in practically unlimited quantity, though what is now in sight will suffice for a generation's work. To all intents and purposes the mine is an open quarry. The ore is got at by chopping off a surface of earth and rock, and then loosening the hermatite with charges of dynamite.

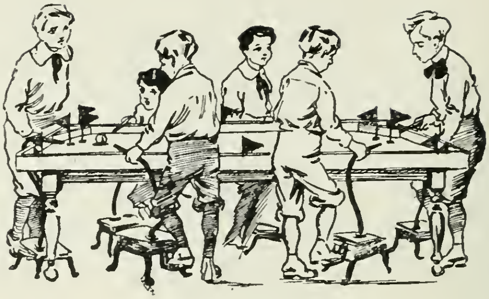
The deposit is one of Nature's freaks. It is a perfect reproduction of a tiled floor. Countless millions of cubes of mineral are laid out with rectangular precision, following the trend of the stratification, and these seem to have been cemented and forced together by some giant machinery in pre-historic days. Layer upon layer of these cubes are seen in a vertical section of the mine, and the lines of cleavage are as clearly perfect as a child's box of blocks. The only difference is that one may not lift one of these mineral cubes with the fingers, but a dynamite charge fixed in a portion of the deposit by a steam drill shatters it for an area of many feet in every direction, and separates the solid mass into thousands of little bricks, each about 3 inches square and as perfect in alignment as if produced by an artist. No mining, in the customary sense, is needed. The deposit lies open to the sun, and all the work involved is the loosening of successive sections and the gathering up of the fragments, which is done by men shovelling them into ore cars, which run on a light cable railway to a pier on the sea shore.

The mine occupies the northern end of the island, and hard by is a sheltered cove, where a pier has been built whence 10,000 tons of ore may be loaded in a day. The laden cars run down an incline by gravity, and are upset automatically, their contents falling into one of ten pockets constructed in the interior of the pier. Each pocket takes a thousand tons, and can be emptied into a steamer's hold in ten minutes. The cost of mining the ore and putting it on shipboard is but 25 cents per ton, and the freight to Canada only 25 cents more, 50 cents being charged for its conveyance to Europe or the United States. It is in great demand in Germany, where ironmasters work it into very conveniently poorer ores, and large quantities of it are also absorbed at Philadelphia and Baltimore. The price at which it sells there yields the owners of the Wabana mine a profit of $1 a ton, and contracts for the delivery of 1,000,000 tons have been signed for this season.

COMPRESSED AIR FOOTBALL

The cut is from a popular daily newspaper and is intended to show the possibilities of a new game apparatus, the following being all the description offered:

"Upon the top of a light table a football "gridiron" is chalked or inked. Goal posts are fastened in their proper places. Each player has a bellows, which is worked by the foot, and a hose with nozzle attached. Tennis balls, or smaller rubber balls are blown about by the bellows. The sides have equal numbers of players, who take turns in blowing the ball toward the opponent's goal posts. Whenever a ball goes off the table, it is brought back and placed on the side-lines where it crossed. The side winning the greatest number of goals in a time agreed upon beforehand gains the victory."



COMPRESSED AIR FOOTBALL.

Why not use the bellows and air jet instead of the cue for pool or billiards? The conditions of chance or skill in the game might be so changed as to render them unrecognizable.

EXTENSIVE NATURAL SAND-BLASTING

The power of the sand blast used in cleaning and renovating our smoke-stained buildings is an adaption of a natural agency which in past ages has done stupendous geological work. Few rocks can withstand the power of sand composed principally of silica or quartz when violently blown against it. The extraordinary monuments that characterize the plateaux of Utah and the Grand Canyon region, including the stupendous "Natural arches," are due in part to water and sand and in part to sand alone driven by the storms of the desert. The larger work, such as the cutting of profound canyons, was undoubtedly due to the erosive action of water carrying sand and pebbles in its grasp. The minor, but no less striking work, such as the whittling away of monuments and the production of top-heavy obelisks with perilously narrow bases, and of mushroom and other grotesque rock forms was largely due to the sand blasts of the desert. Any one who has been exposed to a desert storm knows the sharp cutting effect on the face and hands of blowing sand. Windows facing the West in Colorado may often be observed to be etched or scratched. Carry on these agencies at intervals for hundreds or thousands of years and the effect of blown sand on soft and even hard rocks will be very marked.

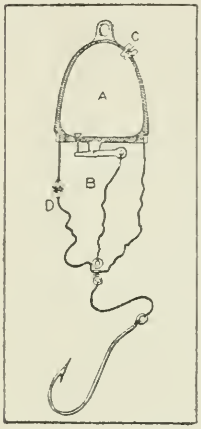
In watching the rapid effect of the sand-blast on our public buildings in Denver, the basements of which may be a coarse red granite, we are astonished that our buildings could be so dirty, or that so much smoky dirt could accumulate in so comparatively short a time, and at the difference between the original stone as it came from the quarry, and as revealed by the sand-blast and its present condition, so that we involuntarily say "look on this picture and on that." It would be a good thing sometimes for a mine examiner if he could use such a sand-blast to clean off the face of a mining tunnel and study the vein, so generally obscured by powder-smoke and dust, in its integrity. So powerful on rocks seems the effect of the sand-blast that we suggest to some inventive person a more extended use for it. It would seem as if here was a legitimate subject for the inventive mind.—*Mining Science.*

A CALCIUM CARBIDE SPRAYER

At a recent meeting of the Faraday Society a gas pressure sprayer, the invention of Mr. W. Tyree, of Sydney, N. S. W., was described. Although the device was introduced only about five years ago, over 5,000 are now in use in Australia. They are chiefly used for destroying all kinds of pests which run riot with fruit trees in Australia, but they are also put to such varied uses as spraying turpentine and zinc-white on the inside of feed tanks of boilers, for spraying disinfectants and for painting and distempering, and many other possible applications readily suggest themselves. The apparatus consists of two iron cylinders, in the larger of which is contained the spraying emulsion, while in the smaller the gas is made by water being allowed to drip at any required rate into the calcium carbide. The two cylinders are fastened together, and riveted to withstand a pressure of 200 lb., the acetylene being generated to only half this pressure, even this exceeding that permitted by the British Board of Trade. If some material could be found to give off a non-inflamable gas the usefulness of the sprayer would be greatly enhanced. As it is, the use of the sprayer in Australia has sent up the consumption of calcium carbide in Australia from 2,000 tons four years ago (at $90 per ton) to over 8,000 tons (at $50 to $60 per ton) last year, a quantity greater than that consumed in Great Britain.

A FISHERMAN'S SINKER FLOAT

The product of piscatorial ingenuity shown in the sketch perhaps shaped itself in the brain of a patient angler while sitting on the river bank waitng for a bite. It was contributed to *Popular Mechanics* by Mr. W. S. Jacobs, Malden, Mass.



The sinker proper is the little metallic chamber *A*, charged with air at a considerable pressure. It can be charged at the air valve *C* just as a pneumatic tire is inflated. Attached to the base of the sinker, all around, is the collapsible, and normally collapsed, bag *B*. Within the bag and fulcraned on the bottom of the sinker is a little lever, the short end of which is connected to an inwardly opening air valve in the bottom of the sinker, while the long end of the lever is connected through the bottom of the collapsible bag to the hook below. When the fish bites the lever opens the valve, the bag is distended by the air, the combined specific gravity of sinker and air bag becomes considerably less than that of the water, and in the long run, in spite of the objections of the fish, the contraption rises to the surface.

PATENTEE'S EXPERIENCES

Mr. Askin Nichols sends from Melbourne, Australia, to *Mining and Scientific Press,* San Francisco, a description or defense of his vacuum filtration process, concluding with the following paragraph:

After giving brains, time, and money to this, one naturally says, "What is the good of a patent office? Is it simply a Government institution to put people at loggerheads and to encourage litigation?" I do not intend these remarks to apply to the patent office of any one country, as there has recently been an instance here (in the Commonwealth) of an important metallurgical patent, namely, the Potter process. After litigation extending over some years, and costing over £20,000, the Privy Council, the highest court of the British Empire, gave a verdict in favor of Potter, but the inventor himself is in his grave. The only thing Potter got out of his invention was worry and anxiety. So far my experience has been the same. Might I suggest for the consideration of international patents' committees that patents be granted with arbitration clauses where they overlap, but only for application in the case of the subsequent applicant introducing new and valuable matter. This would relieve many difficulties.

METERING AIR LIFTS

The city of Galveston, Tex., is installing an air meter at the pumping station and wells at Alta, Loma, for the purpose of measuring the air used in each of the 30 wells to raise the water used in the city. The air compressor plant installed about a year ago has a capacity of 1,200 cu. ft. of free air per minute. This compressed air is distributed to the wells which extend over a territory three miles long, but it is not known what each well gets. With the installation of the air lifting plant the capacity of the wells has been more than doubled. Formerly, and before putting in the air plant, the pumping station pulled on an average between 2,500,000 and 3,000,000 gallons a day out of the wells. It is now possible to pump and supply Galveston with 7,000,000 gallons a day. —*Municipal Journal and Engineer.*

PURE AIR FOR STREET CARS

The Chicago Health Department has submitted to the Council a new code for the regulation of street cars in which occur the following provisions:

"There shall be introduced into every car 350 cubic feet of air every hour for each passenger.

"The minimum amount of air to be introduced into a loaded surface or elevated coach shall be 28,000 cubic feet each hour.

"There shall be at no time in excess of one-tenth of 1 per cent. of carbon dioxide gas in the atmosphere which passengers have to breathe.

"The air shall be conducted into the car through the floor.

"Exhausted air shall be conducted out of the car through overhead ventilators, but no air shall be allowed to enter by that route.

"During cold weather the air which is admitted shall pass over heating coils and be warmed as it comes in.

"In any car or part of a car where smoking is permitted the supply of air shall be at least one-third greater."

How the volumes of air are to be measured, or tests of air conditions are to be made, do not seem to be suggested.

COST OF MANUFACTURING A MINING ENGINEER

The cost of producing a young mining engineer, from his birth to his day of graduation, has cost somebody—father, city, state or nation—not far from $10,000. Is it worth while to put this amount of capital into a mere artisan-engineer? I think not. It becomes a case of polishing bricks. But if this expenditure produces an artist-engineer, the nation has made a judicious investment, because the chance for the untrained or uneducated man to make a success in this age is practically nil. Taking "Who's Who" as a standard of national prominence it is found that it takes approximately 10,000 grammar school graduates to produce one man worthy to be enrolled in "Who's Who." Of High School graduates 250 will suffice, while out of only fifty college graduates one will, on the average, rise to sufficient prominence to be enrolled in this book. More evidence of the practical value of an education is hardly necessary. There is never an overproduction of artist-engineers, only a surplus of the artisan variety. *Victor C. Alderson, Pres't Col. School of Mines.*

Measured by selling values the production of natural gas in this country more than doubled between 1901 and 1908. The total volume produced in 1908 was 402,140,730,000 cubic ft., a decrease of about 2,500,000,000 cubic feet from 1907. Pennsylvania led with 130,476,237,000 cubic feet, West Virginia being second, 112,181,278,000 cubic feet; Kansas, 80,740,264,000; Ohio, 47,442,393,000, and Oklahoma 11,924,574,000.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
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H. L. KEELY, - - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. MAY, 1910. No. 5

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A BILLION DOLLARS FOR NEW YORK CITY IMPROVEMENTS

According to plans now formulated, and with some of the work already under way, New York City has in view municipal improvements mostly in the engineering field and to be completed within the next fifteen years which will involve an expenditure of $1,000,000,000. In this estimate a great variety of work is of course included, without mentioning the Catskill aqueduct which is advancing rapidly towards completion.

Perhaps the most striking single item is the construction of an entirely new and adequate harbor which may eventually effect an entire rearrangement of freight and even of passenger traffic and tend also toward the relocation of residence and business centres. The harbor spoken of will be secured by the conversion of the shallows and marsh lands of Jamaica Bay into a sheltered but directly approachable harbor with an anchorage area of 25 square miles and providing for hundreds of miles of wharfage. This new harbor, besides providing improved facilities for the present and growing city trade, will also form an adequate terminal for the State barge canal now far under way for connecting the Hudson and the Atlantic with the great lakes.

New subways are planned to cost at the present figures $200,000,000, but before these are completed they will be inadequate for the ever growing travel and more will be wanted at once. Then there is the North River bridge and more tunnels. Improvements in another line are planned in connection with the city's means of surface transportation. This will involve the elevation or depression of intersecting streets at some of the busier points. Traffic on certain of the streets has now become so great that at certain points where they cross and interfere it will not be feasible much longer to have the streets on the same grade.

The work thus indicated is strictly municipal in character and there may be as much more demanded in the same time for the railroads and for corporate and individual needs. The unbuilding and the rebuilding of the city goes on continually, and this certainly shows no promise of abatement. At the present writing, a sixteen story building with pneumatic foundations and steel frame throughout, an entirely modern structure, is being torn down in the heart of the financial district to be followed by the erection of another of nearly double the height and more than double the horizontal area, and so it goes.

By all this we are assured that whatever changes may come compressed air is sure of its job in New York City, for it is one of the agencies now first thought of and most constantly employed in all the lines of work here indicated.

FATAL EXPLOSION OF OXYACETYLENE APPARATUS

At an automobile repair shop in New York City there recently occurred a disastrous and somewhat inexplicable explosion of the oxygen tank and generator of an oxyacetylene welding apparatus, by which one man was literally blown to pieces and another severely injured, while apparently the acetylene had nothing to do with it. The matter was thoroughly investigated by one of the editorial staff of the *American Machinist* from whose account we condense as follows:

The acetylene used in this apparatus was generated in a tank in the usual way by the action of water upon calcium carbide, and the acetylene flame was used for heating two cylindrical retorts 4 in. diameter and 14 in. long for generating the oxygen which was conducted from them by a ⅜ in. pipe to a steel storage tank 14 in. in diameter and 6 ft. high. The retorts were closed at one end by a hemispherical head integral with the shell, and at the other by a screwed flange with a cover bolted on. One flange and cover was blown off by the explosion and the end of the shell was torn open about 2½ in. long, while the other retort was practically uninjured.

The really terrific explosion was that of the large oxygen storage tank. The side of this was torn open, not at the seam, but in the solid metal from end to end, and the sheet, which is about 3-16 inch thick, was bent completely back, literally turning the tank inside out. With an oblique, jagged tear one-half of the sheet was twisted and reversed end for end, and in one place a ragged hole seemed to show where in its passage through the roof of the building it was pierced by something hard and strong. One large piece was torn completely out of the sheet, this embracing about half the diameter and one-third of the height.

The explosion was not due to defective material, nor to a gradual increase of pressure above the normal to the bursting point, either of which causes would naturally be suggested. The access of pressure must have been sudden and, for the instant, far above the strength of the material. From the distribution of the damage effect it would at first appear that the explosion took place in the storage tank; and the instantaneous increase in pressure which may have occurred in this tank first, could have had full opportunity to destroy this tank, while the comparatively small diameter of the connecting pipe choked back the pressure sufficiently to produce only the comparatively slight damage to the generator, before the pressure was relieved by the explosion.

It may be contended, however, that the resulting destruction to the storage tank was the greater because it was so much larger and of so much thinner material relatively to its diameter. This is apparently perfectly possible, and so it is also possible that the explosion came from the materials for generating the gas in one of the retorts.

The fact that one generator was apparently uninjured seems to favor this theory, because we may in that case assume that the explosion started in the other generator, that the pressure then reached the storage tank with power enough to burst it while the small diameter of the pipe connecting the second generator and the relief of the pressure in the storage tank by its bursting both combined to save the second generator from the destructive access of pressure. What could have caused the chemicals to explode in the bursted generator it would be difficult to say, unless it was some entirely foreign impurity.

If the origin of the catastrophe is assumed to have been in the storage tank, there seems to be nothing to suggest the cause of the explosion. This tank was simply a cylindrical steel shell to hold the oxygen generated. The usual working pressure was about 150 pounds and this is assumed to have been the pressure up to the moment of the explosion.

Pure oxygen is nonexplosive. It is the active agent of the atmosphere and naturally will not burn in air. Oil, or other carboniferous substance, however, once ignited burn violently in oxygen, producing a high temperature, and pressure if in a confined space. It is possible, therefore, that some such foreign substance was inside the oxygen apparatus and this, acted upon by the heat employed to generate the oxygen, caused ignition and explosion.

There was no connection between the acetylene generator and the oxygen tank, so it seems impossible that there could have been any mixture of the two gases inside the apparatus. As a matter of fact, the acetylene flame is said to have been extinguished by the explosion, the acetylene generator being unharmed. This fact and also that the building at once took fire, would seem to indicate that the explosion itself produced a flame.

A full knowledge of all the facts in this case, and a complete understanding of the sequence of occurences, should lead to a clear interpretation of the effects from the causes, and should ultimately result not in retarding the use of the valuable oxyacetylene process, but in surrounding it with increased guarantees of safety.

"STAR" AIR COMPRESSOR FOR MOTOR BOATS

The "put-put," or gasoline motor boat is rapidly driving the row-boat out of existence. Its speed, combined with the inconvenience of sudden or frequent stoppage, makes a ready whistle necessary, and the whistle calls for a constant supply of compressed air to blow it. The designer of the little compressor shown in Fig. 1, he being a provider of marine hardware and mechanical supplies for motor boats and recognizing this existing requirement, proceeded to supply it with the result here shown.

The compressor is a very simple combination of essential elements and requires little explanation. There is a plunger operated by the direct thrust of a cam on the propeller shaft, the bearings fitting the shaft on each side of the cam, and the cylinder lying horizontally or at any angle on either side of the shaft or standing vertical if so required. A light spring holds the plunger always in contact with the cam when compressing, so that there is no lost motion or backlash, while the plunger is instantly thrown out of action by the lever seen in front. The short end of this lever catches over the end of the plunger, and its face is sufficiently beveled to push the plunger entirely out of contact with the cam. Air sufficient to blow the whistle is produced in half a minute, although normally the receiver is kept filled with air up to 50 or 60 pounds. If it is not convenient to slip the bearings and cams over the end of the shaft, they are made so that they can be clamped on.

Fig. 2 shows a complete outfit as usually supplied, comprising receiver, pressure gage, whis-

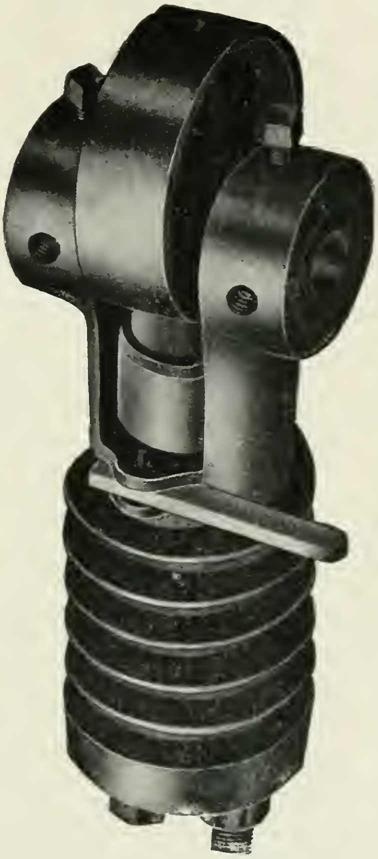


FIG. 1. STAR AIR COMPRESSOR.

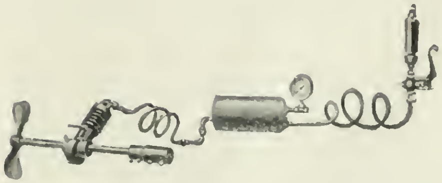


FIG. 2. WHISTLE BLOWING OUTFIT.

tle, copper pipe which can be bent to lead anywhere and all the necessary small fittings. Further detailed particulars are furnished by the makers, W. & J. Tiebout, 118 Chambers St., New York City.

C°	0	10	20	30	40	50	60	70	80	90
	F	F	F	F	F	F	F	F	F	F
—200	—328	—346	—364	—382	—400	—418	—436	—454		
—100	—148	—166	—184	—202	—220	—238	—256	—274	—292	—310
—0	+32	+14	—4	—22	—40	—58	—76	—94	—112	—130
0	32	50	68	86	104	122	140	158	176	194
100	212	230	248	266	284	302	320	338	356	374
200	392	410	428	446	464	482	500	518	536	554
300	572	590	608	626	644	662	680	698	716	734
400	752	770	788	806	824	842	860	878	896	914
500	932	950	968	986	1004	1022	1040	1058	1076	1094
600	1112	1130	1148	1166	1184	1202	1220	1238	1256	1274
700	1292	1310	1328	1346	1364	1382	1400	1418	1436	1454
800	1472	1490	1508	1526	1544	1562	1580	1598	1616	1634
900	1652	1670	1688	1706	1724	1742	1760	1778	1796	1814
1000	1832	1850	1868	1886	1904	1922	1940	1958	1976	1994
1100	2012	2030	2048	2066	2084	2102	2120	2138	2156	2174
1200	2192	2210	2228	2246	2264	2282	2300	2318	2336	2354
1300	2372	2390	2408	2426	2444	2462	2480	2498	2516	2534
1400	2552	2570	2588	2606	2624	2642	2660	2678	2696	2714
1500	2732	2750	2768	2786	2804	2822	2840	2858	2876	2894
1600	2912	2930	2948	2966	2984	3002	3020	3038	3056	3074
1700	3092	3110	3128	3146	3164	3182	3200	3218	3236	3254
1800	3272	3290	3308	3326	3344	3362	3380	3398	3416	3434
1900	3452	3470	3488	3506	3524	3542	3560	3578	3596	3614
2000	3632	3650	3668	3686	3704	3722	3740	3758	3776	3794
2100	3812	3830	3848	3866	3884	3902	3920	3938	3956	3974
2200	3992	4010	4028	4046	4064	4082	4100	4118	4136	4154
2300	4172	4190	4208	4226	4244	4262	4280	4298	4316	4334
2400	4352	4370	4388	4406	4424	4442	4460	4478	4496	4514
2500	4532	4550	4568	4586	4604	4622	4640	4658	4676	4694
2600	4712	4730	4748	4766	4784	4802	4820	4838	4856	4874
2700	4892	4910	4928	4946	4964	4982	5000	5018	5036	5054
2800	5072	5090	5108	5126	5144	5162	5180	5198	5216	5234
2900	5252	5270	5288	5306	5324	5342	5360	5378	5396	5414
3000	5432	5450	5468	5486	5504	5522	5540	5558	5576	5594
3100	5612	5630	5648	5666	5684	5702	5720	5738	5756	5774
3200	5792	5810	5828	5846	5864	5882	5900	5918	5936	5954
3300	5972	5990	6008	6026	6044	6062	6080	6098	6116	6134
3400	6152	6170	6188	6206	6224	6242	6260	6278	6296	6314
3500	6332	6350	6368	6386	6404	6422	6440	6458	6476	6494
3600	6512	6530	6548	6566	6584	6602	6620	6638	6656	6674
3700	6692	6710	6728	6746	6764	6782	6800	6818	6836	6854
3800	6872	6890	6908	6926	6944	6962	6980	6998	7016	7034
3900	7052	7070	7088	7106	7124	7142	7160	7178	7196	7214
C°	0	10	20	30	40	50	60	70	80	90

C°	F°
1	1.8
2	3.6
3	5.4
4	7.2
5	9.0
6	10.8
7	12.6
8	14.4
9	16.2
10	18.0

F°	C°
1	56
2	1.11
3	1.67
4	2.22
5	2.78
6	3.33
7	3.89
8	4.44
9	5.00
10	5.56
11	6.11
12	6.67
13	7.22
14	7.78
15	8.33
16	8.89
17	9.44
18	10.00

EXAMPLES: 1347°C = 2444°F+12°.6F = 2456°.6F: 3367°F = 1850°C+2°.78C = 1852°.78C

TEMPERATURE CONVERSION TABLE

The table on the opposite page, arranged by Dr. Leonard Waldo, 49 Wall street, New York city, is, we think, the most compact, convenient and complete ever devised for this specific purpose. By the adoption of the scheme often used in logarithmic tables, every unit of temperature from that of liquid air to the arc is included, and all the figures are exact instead of approximate, as might be expected.

The conversions are also in both directions, from centrigrade to Fahrenheit and vice-versa, as may be required. The table as here presented is a photo-engraved reproduction from a page of *Metallurgical and Chemical Engineering*.

AN INTERNATIONAL CONGRESS OF INVENTORS

The first national convention of the International Congress of Inventors is to be held in Rochester, N. Y., June 13 to 18, 1910.

This organization was established in Rochester in 1906 and was incorporated 1907. Its purposes, briefly, are:

To establish a standing for a United States patent independent of any court action.

To procure necessary legislation, Federal or State.

To reform abuses and secure freedom from unlawful and unjust exactions.

To promote intercourse among the members.

To maintain permanent headquarters.

To present the solid front of a strong international organization for asserting the rights of members, individually or collectively.

To acquaint the members with what is going on in the world.

To give advice to members upon specific questions which arise.

To keep always prominent the mutual advantages of organization and cooperation.

In connection with and a part of the convention will be an exhibition of patents, comprising models of patents as samples of modern ingenuity, and complete machines and devices embodying patents for the purpose of commercial publicity, for the latter class of exhibits some charge being made for space. The Secreeary is Ralph T. Olcott, Rochester, N. Y.

NOTES

By a recent count the average number of rock drills in use in the mines of the Rand is 3,258.

It is estimated that to completely scrap the British battleship Thunderer, built in 1877, will require the work of 100 men for nearly two years. The usefulness of this ship, as of many others, during the thirty-three years of its existence, has been entirely of the "moral" kind, as it has never appeared in war.

The rare non-metallic element selenium has peculiar properties. In the dark it is a poor conductor of electricity, but in the light it becomes a good conductor, and on account of this it is used in a number of electrical devices. It has been used in telephoning along a ray of light and also in transmitting pictures by telegraph.

It may be said to be now only a question of time as to the building of a tunnel in Boston connecting the station of the Boston & Maine and the New Haven roads, or, as they are locally known, the North and the South stations. Estimates of the total expenditure involved amount to $16,000,000.

Mrs. Elmer Woodbury, of Oakland, Cal., is the inventor of a man-operated street sweeper, combining the principals of the carpet sweeper and the compressed air or vacuum cleaning machine. The inventor claims that the machine is chiefly valuable for its sanitary features.

Professor Jos. W. Richards, of Lehigh University, says: "We feel confident in predicting that when a blast furnace is run on air enriched by 5 per cent. in oxygen, it will run normally one-third faster than when run with ordinary air, and will save probably one-sixth the fuel requirement."

The steel used in drilling the new tunnels for the Pennsylvania Railroad through the diabase mass of Bergen Hill, N. J., including that lost and scrapped, was almost exactly 1 ft. for each 10 cu. yds. of excavation, or 1¼ in. per cu. yd. The loss due to sharpening was the greater portion of this, being ¾ to ⅞ in. per cu. yd., the work being done with an "Ajax" sharpener.

C. Drucklieb, 178 Washington street, New York City, has disposed of his interest in the manufacture and sale of the Injector Sand Blast Apparatus to James M. Betton, who has had the practical management of this branch of his business for the past five years. The business will be carried on, as heretofore, under the name of J. M. Betton, at 178 Washington street, New York City.

On March 2, shortly before midnight, a powder magazine exploded in the "Mexican" shaft of the Treadwell gold mines on Douglass Island, near Juneau, Alaska. Within 30 ft. of the magazine a group of miners was assembled waiting for the cage to take them to the surface, and 31 of them were killed outright while two died later from injuries. The magazine contained about 275 lbs. of powder. The Treadwell mine employed about 1,400 men.

Vice-Consul-General J. J. Slechta writes that plans have been completed for installing in Rio de Janeiro a modern pneumatic-tube system for transmitting telegrams and other messages. The topographical position of the Brazilian capital necessitates its separation into distinct and widely separated districts, between which communication is slow, because of the circuitous route, to avoid mountainous districts, either by tramway or other street vehicle.

A process of disinfection has been recommended by Dr. Le Faguays which is to consist in blowing upon the contaminated surfaces a current of air heated to a very high temperature (600 to 900 deg. F.). This process may be applied not only within buildings, but also to the surface of streets, yards, etc. The apparatus is heated by petroleum and is very simple. This process not only destroys disease germs, but it is very efficacious against fleas and other vermin.

Secretary Ballinger of the Interior Department, in a recent address at St. Paul, Minn., said that while the doctrinaires figure that the coal deposits of the United States and Alaska will be exhausted in a period of 100 years the fact is that, according to the production of coal in the United States at the close of 1908, only 0.4 of 1 per cent. of the original supply of coal had been exhausted, leaving us the apparent supply still available 99.6 per cent. of the original supply, or coal enough to last, as some assert, for a period of 7,000 years."

A novel use for Thermit was found last year by the Chicago, Great Western Railroad when it was decided to change the stroke of some of the locomotives. To do this it was, of course, necessary to fill up the crank-pin holes of the driving wheels, and to bore new holes at the desired distance from the center for the new stroke. The Thermit process was used for filling the holes of a set of wheels, thus saving the cost of new cast steel wheel centers. With the new crank-pins in place the locomotive was fitted with new cylinders and has since been in service for over a year.

Hydraulic power mains aggregating more than 164 miles, are in use in the London district of the London Hydraulic Power Company. Water is distributed from a large station near the Thames under a pressure of 700 lbs. per square inch; the total yearly supply is said to be about 900,000,000 gal. The power is used principally by hydraulic elevators. The number of machines of all classes connected to the power mains increased from 3,240 in 1898 to 6,368 in 1908.

The secretary of a special Spanish commission appointed to consider the extermination of locusts informs Consul Percival Gassett, of Jeres de la Frontera, that about 20 different kinds of sprayers, sprinklers, and burners were tried. A certain one for which a patent has just been applied for was the best. It is made by a tinsmith there and sold at $9, plus packing and freight. A gasoline air-pressure flame is used. A drawing of the mechanism is on file for reference at the Bureau of Manufactures.

The mean height of all land above sea level is estimated at nearly 1,800 ft., the figures for the several continents being as follows: Europe, 975 ft.; Asia, 2,880 ft.; North America, 2,000 ft.; South America, 1,750 ft.; Africa, probably about 2,000 ft. The mean height of the United States, Alaska excluded, is 2,500 ft. Colorado is the highest, averaging 6,800 ft.; Wyoming, second, with 6,700 ft., and Utah third with 6,100 ft. Delaware only averages 60 ft. above sea level. The lowest land in the United States is Death valley, on the southeast border of California, which descends 480 ft. below sea level and is bounded on the east by the Funeral mountains, 7,000 ft., and on the west by the Panimint range, 11,000 ft. high.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 1.

950,477. BRAKE-OPERATING MECHANISM. Luke Courtois, Appleton, Wis.

950,495. VACUUM-PRODUCING APPARATUS. Lemuel W. Serrell, Plainfield, N. J.

950,531. TRACK-SANDING DEVICE. John Gapp, Scranton, Pa.

950,539. AIR-BRAKE. William B. Mann, Baltimore, Md.

950,550. AIR-HEATER FOR AUTOMOBILE TORPEDOES. Frank M. Leavitt, New York, N. Y.

950,663. AIR-PIPE COUPLING. William J. Ellis, Andrews, N. C.

950,703. APPARATUS FOR PRODUCING OXIDS OF NITROGEN FROM THE AIR. Francis I. du Pont, Wilmington, Del.

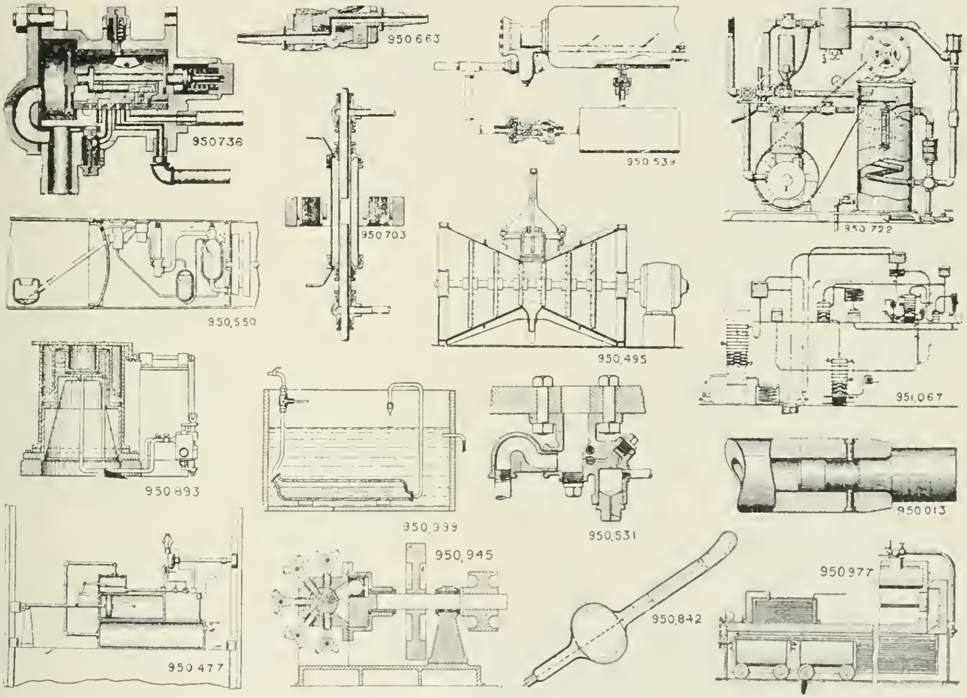
950,722. PNEUMATIC CLEANING SYSTEM. George J. Kindel and Arthur W. Kindel, Denver, Colo.

950,736. COMBINED AUTOMATIC AND STRAIGHT AIR BRAKE. Walter V. Turner, Wilmerding, Pa.

950,842. MONOPOLAR VACUUM-TUBE. Frank A. Davis, Boston, Mass.

950,893. JARRING-MACHINE. Philip J. Conboy and James A. Murphy, Hamilton, Ohio.

3. A jarring machine comprising a column consisting of superposed cylinders of different diameters and formed with an expansion chamber in its upper portion, a counterbored cylinder arranged to slidably engage with the column and formed with a piston and with an annular expansion chamber concentric therewith adapted to slidably engage with the upper portion of the column, passages communicating with said chambers from a source of air under pressure, valves for controlling said passages simultaneously and connections with the counterbored cylinder for operating the valves.



Pneumatic Patents, March 1.

950,945. FLUID-PRESSURE MOTOR AND PUMP. Thomas Moss, Portsmouth, and William Moss, Wigan, England.

950,977. MEANS FOR DEODORIZING AND DRYING NIGHT-SOIL AND THE LIKE. Earnest T. Welcome, Pittsburg, Pa.

4. Improvements of the character described comprising a furnace, an oven connected with said furnace, several cars in said oven, each of said cars having a chamber or chambers communicating with the car's interior, and means for forcing air through said chambers.

950,999. APPARATUS FOR AERATING WATER. Georg Erlwein, Berlin, and Ernst Marquardt, Karow, near Berlin, Germany.

951,013. TOOL-HOLDER FOR PNEUMATIC HAMMERS. Victor E. Lane, Berwick, Pa.

951,067. APPARATUS FOR RECOVERING ETHER AND ALCOHOL. Charles Crepelle-Fontaine, La Madeleine lez Lille, France.

1. An apparatus for recovering ether and alcohol, comprisng an absorption receptacle, means for delivering the *air charged with ether and alcohol* to said receptacle, means for feeding an acid to the upper part of said receptacle, an acid tank, means for carrying the acid saturated with the ether and alcohol from the receptacle to said tank, a recovering apparatus comprising means for separating ether and means for separating alcohol and means for connecting said apparatus with the acid tank.

MARCH 8.

951,110. APPARATUS FOR RECOVERING ALCOHOL FROM THE LINING OF BARRELS, ETC. Joseph J. Gilchrist, Pittsburg, Pa.

951,154. MONOPLANE AEROPLANE. Robert W. Stewart, East Oakland, Cal.

951,162. CENTRIFUGAL APPARATUS FOR COMPRESSING AND PROPELLING FLUIDS. Carlo Wedekind, St. Jean-sur-Mer, France.

951,196. AUTOMATIC AIR STEAM CONNECTION. Herkimer L. Miner, St. Louis, Mo.

951,222. WINDOW-GLASS-DRAWING MACHINE. Charles M. Resslar, Jeannette, Pa.

1. In a continuous glass drawing machine the combination with an air pipe, a piston carried by said air pipe and means for raising a glass cylinder after the cylinder has been started.

951,465. ROTATION DEVICE FOR FLUID-PRESSURE-OPERATED-HAMMER TOOLS. ALBERT H. TAYLOR, Easton, Pa.

951,513. FLUID-PRESSURE REGULATOR. EDWARD J. ROHRBACHER, Blaine, Wash.

951,529. AIR-PUMP. JUSTIN S. HEMENWAY, River Falls, Wis.

951,559. DRYING APPARATUS. JOHN H. DUNCAN, Ithaca, N. Y.

951,566. PRESSURE-RETAINING DEVICE FOR AIR-BRAKES. JOHN C. HUXHOLD, Chicago, Ill.

951,585. AEROPLANE. HERMAN F. WEIDEL, Rochester, N. Y.

951,615. FLYING-MACHINE. LEO C. KINCANNON, Seabright, Cal.

951,625. AIR-OPERATED FIRE-EXTINGUISHER. PETER L. WILBUR, New York, N. Y.

951,711. VOLUME-RECORDING ATTACHMENT FOR FLUID-METERS. HENRY P. WESTCOTT, Erie, Pa.

1. In a pneumatic track sander, the combination with the base and floor of the sand box, of a sander body beneath the said floor having a sand inlet hole through the said floor and a sand discharge hole through the wall of the base, and an air discharge nozzle within said sander body and opposite to said sand discharge hole.

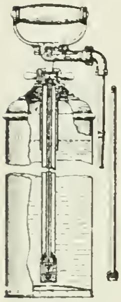
952,121. COCK-CONTROLLING DEVICE FOR AIR-BRAKE SYSTEM. VICTOR J. KOEHLER, Punxsutawney, Pa.

952,244. PORTABLE VACUUM CLEANING DEVICE. JAMES GARDNER, Baltimore, Md.

952,262. PNEUMATIC MUSICAL INSTRUMENT. EUGENE DE KLEIST, North Tonawanda, N. Y.

952,299. AIR-BRAKE. WILLIAM S. BILBREY, West Point, Ga.

952,416. PRESSURE REDUCING AND REGULATING VALVE. JEHU V. CHASE, Newport, R. I.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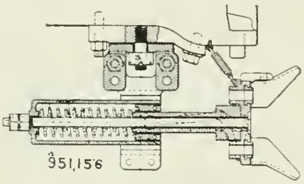
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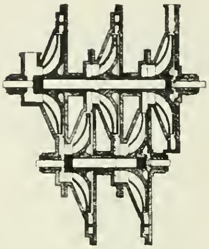
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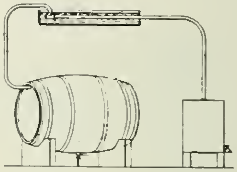
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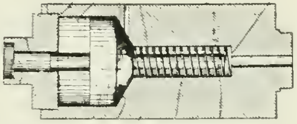
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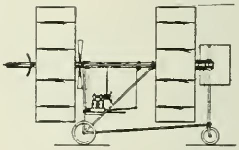
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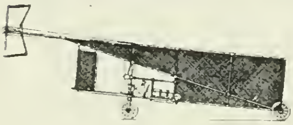
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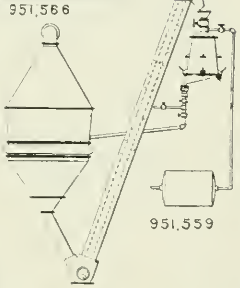
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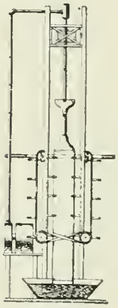
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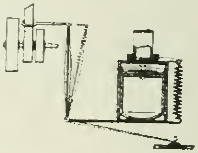
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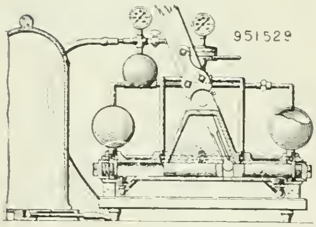
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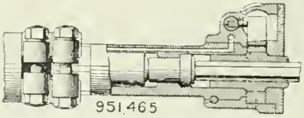
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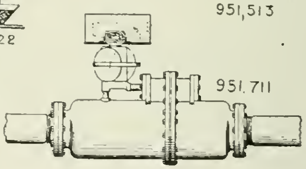

951,711

PNEUMATIC PATENTS, MARCH 8.

MARCH 15.

951,789. OZONE-GENERATOR. FRANK M. ASHLEY, New York, N. Y.

951,822. AIR-VALVE. GEORGE LEICH, New York, N. Y.

951,889. PIPE-COUPLING. WILLIAM H. TENER, Carterville, Mo.

951,899. WINDMILL CONSTRUCTION. EMERSON F. BALDWIN, Philadelphia, Pa.

951,987. DIRECT AIR-BRAKE SYSTEM. ARTHUR DOAN, Oakland, Cal.

952,070. AIR-BRAKE-SYSTEM SIGNALING APPARATUS. SIMON P. COTA, Dickinson, N. D.

952,111. TRACK-SANDER. JOHN H. HANLON, Somerville, Mass.

952,440. AIR-PUMP. CHARLES B. DALZELL, Little Falls, N. Y.

MARCH 22.

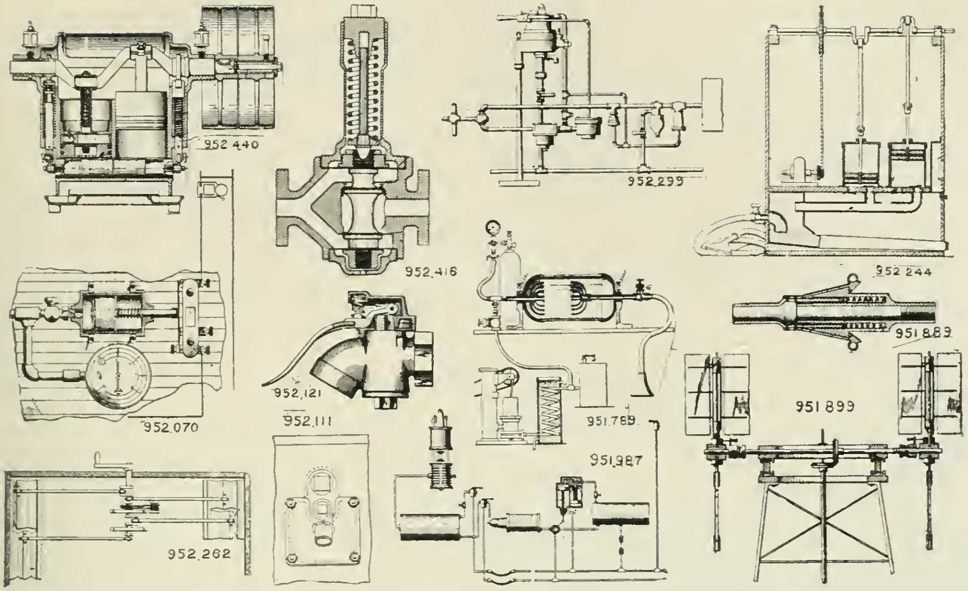
952,452. AUTOMATIC DEPTH-REGULATING DEVICE FOR FREELY-SUBFLOATING BODIES. KARL O. LEON, Gottenberg, Sweden.

952,495. SUCTION SUPPORTING DEVICE. CHARLES A. AUSTIN, New ,York, N. Y.

952,522. AIR-BLAST DISTRIBUTER. WILLIAM T. HENDRYX, Portland, Oreg.

952,617. PRESSURE-PUMP. FREDERICK W. HUMBARGER, Herrington, and DAVID J. FOREMAN, Kansas City, Kans.

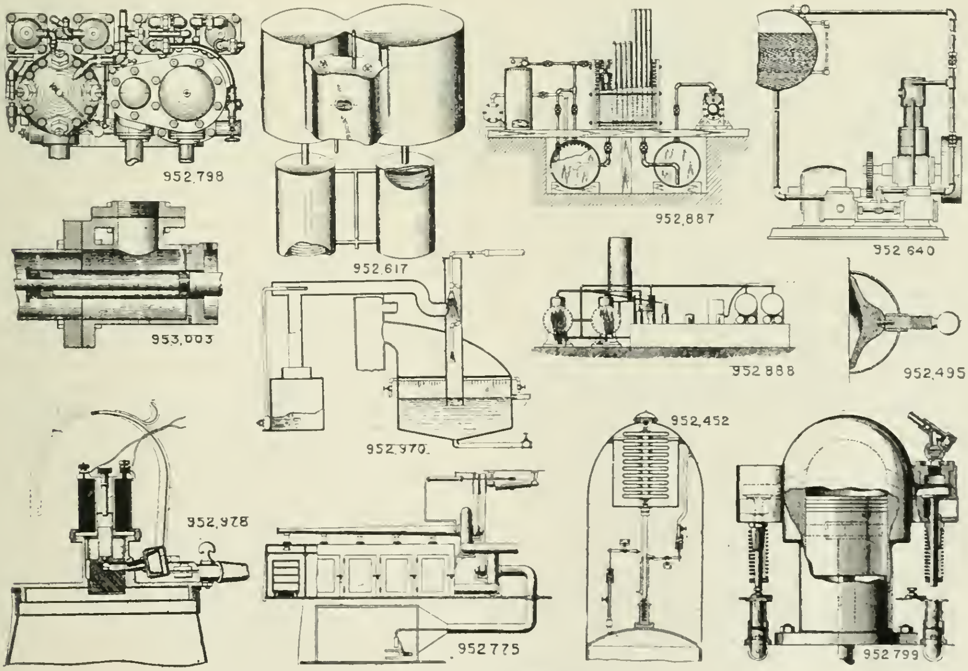
952,640. POWER SET FOR AUTOMATIC SPRINKLERS. EDWARD A. RIX, San Francisco, Cal.



Pneumatic Patents, March 15.

1. A power set comprising in combination a suitable pump, a suitable air compressor and a pressure tank, air connection between the compressor and tank, connections with both the compressor and the tank by which the pump can be run either from the compressor or from the tank, or both, and water connections between the pumping end of the pump and the tank.

952,707. PNEUMATIC HAMMER. Max Maximilian, Buffalo, N. Y.



Pneumatic Patents, March 22.

952,775. DRIER. Marshall Whitlatch, Montclair, N. J.

1. In a drier, in combination, a chamber, means for causing a flow of air through the chamber under predetermined pressure and exhaust, and automatic means for maintaining the predetermined pressure and exhaust constant.

952,798. AIR-COMPRESSOR. Edson F. Gallaudet, Norwich, Conn.

952,799. DEVICE FOR SUPPLYING COMPRESSED AIR. Louis Galli, New York, N. Y.

952,887. WOOD-PRESERVING APPARATUS. Patrick F. Dundon, San Francisco, Cal.

2. In an apparatus for treating timber, the combination with a tank, two receivers, pipes leading from the tank into the bottom of the receivers, of a steam boiler and an air pump, pipes connecting the steam boiler with one of the receivers, and pipes conecting the air pump with the top of the other receiver whereby the contents of the receivers may be forced into the tank.

952,888. PROCESS OF CRESOTING WOOD. Patrick F. Dundon, San Francisco, Cal.

1. The herein described process of treating wood for preservative purposes, which consists in first extracting the water from the cells by applying steam and radiant heat to the wood in a retort, then applying a vacuum to draw off the water and vapor, then submerging the material under treatment in a preservative liquid, then forcing into the retort an additional quantity of preservative liquid under pressure, then removing the liquid from the retort by means of a gas under pressure, and finally creating a vacuum for removing any surplus liquid.

952,970. FUME-ARRESTER. Claude C. Whitmore, Butte, Mont.

1. In a fume arresting system, a furnace, an exit flue, an air blast communicating therewith, a water tank, a condensing pipe in communication with said exit flue carried by said water tank and arranged to normally project underneath the water, a spraying device disposed in said condensing pipe, a perforated water pipe arranged in the top of said tank above the surface of the water, settling tanks and an evaporating device connected with said water tank.

952,978. ELECTRIC VACUUM MILKING-MACHINE. George B. Cramp, Duquesne, Pa.

952,993. FAN-BLOWER. August Mathis, Chicago, Ill.

953,003. HYDROPNEUMATIC PUMP. Frederick J. Emeny, Salem, Ohio.

MARCH 29.

953,040. PRESSURE-REGULATOR. Heinrich Kruger, Berlin, Germany.

930,042. DENTAL HOT-AIR APPLIANCE. Walter Lamb, Hanover, Pa.

953,133. VALVE FOR REGULATING THE VOLUME AND PRESSURE OF FLUIDS. Robert L. Frink, Belle Vernon, Pa.

953,198. FLYING-MACHINE. Daniel C. Funcheon, Denver, Colo.

953,213. FLUID-PRESSURE GOVERNOR. George Macloskie, Schenectady, N. Y.

953,228. VACUUM AIR-SANDER. Charles A. Pratte, Denver, Colo.

953,263. PNEUMATIC TOOL. James A. Gallagher, Midford Station, N. Y.

953,334-5-6. METHOD OF OPERATING COMPOUND COMPRESSED-AIR ENGINES. Charles B. Hodges, Pittsburg, Pa.

953,403. FLUID-PRESSURE REGULATOR. Walter V. Turner, Wilkinsburg, Pa.

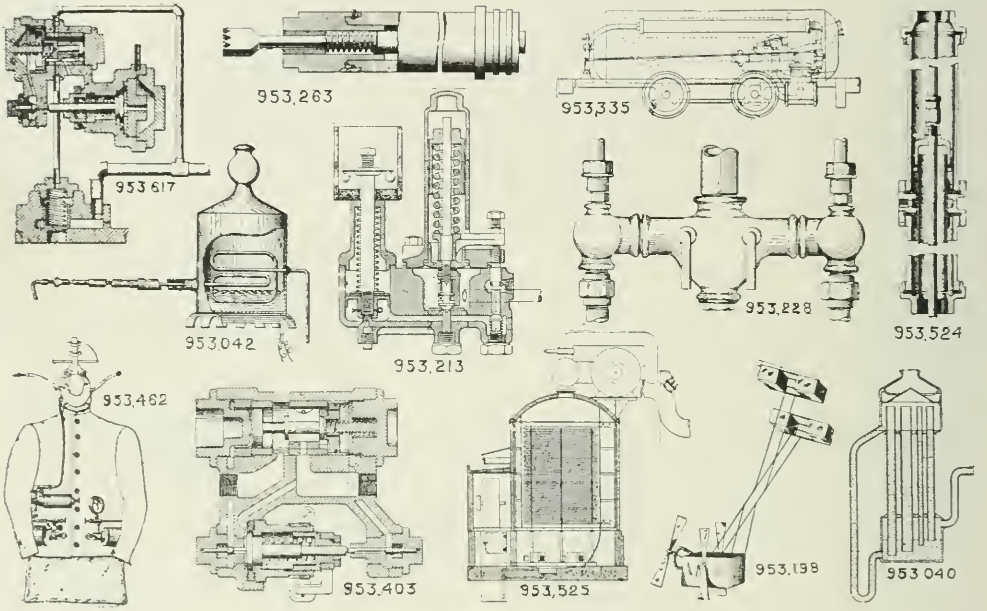
953,462. RESPIRATION APPARATUS FOR USE IN COAL-MINES AND OTHER PLACES. William E. Garforth, Normanton, England.

953,524. COMBINED AIR AND WATER PUMP. Jesse B. Garber, Salem, Ohio.

953,525. APPARATUS FOR EXTRACTING MOISTURE FROM AIR FOR BLAST-FURNACES AND CONVERTERS. James Gayley, New York, N. Y.

953,617. AUTOMATIC CONTROLLING DEVICE FOR FLUID-COMPRESSORS. Herbert T. Herr, Denver, Colo.

953,651. ROCK-DRILLING MACHINE. Lee West, Ironton, Ohio.



Pneumatic Patents, March 29.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV JUNE, 1910 No. 6

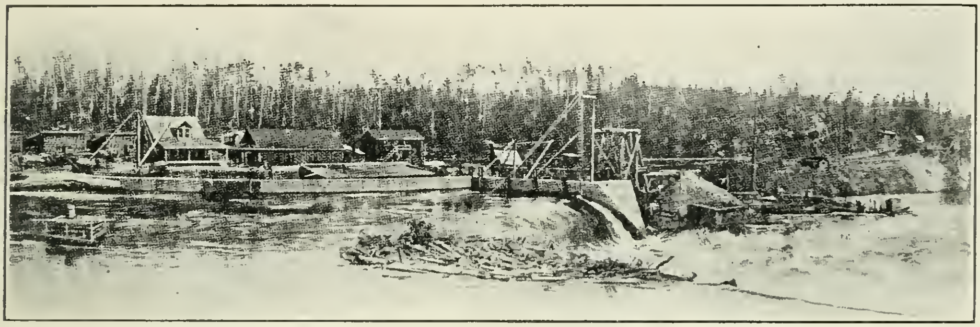


FIG. 1. SURFACE WORKS OF COBALT HYDRAULIC AIR COMPRESSOR.

THE TAYLOR HYDRAULIC AIR COMPRESSOR AT COBALT, ONTARIO

What is undoubtedly the largest single unit air compressor in the world is being constructed on the Montreal River at Ragged Chutes, about nine miles south of Cobalt, Ontario, Canada. This plant operates on the now well known Taylor system, where the air is compressed by the direct action of falling water. The following account may be accepted as authoritative in every particular, having been prepared by Mr. C. H. Taylor for *Mines and Minerals,* from whose pages it is here reproduced, somewhat abridged and rearranged.

The Cobalt Hydraulic Power Company, Limited, is a commercial organization formed for the purpose of selling compressed air to the various Cobalt mines. At Ragged Chutes there is a drop in the river of 54 feet within less than a quarter of a mile. This entire head is to be utilized, furnishing 5,500 horse power and compressing 40,000 cubic feet of free air per minute to a gage pressure of 120 pounds, which is automatically reduced to and maintained at 100 pounds when delivered to the various mines. The air will be transmitted through 9 miles of 20 inch pipe, from the end of which there are two 12 inch branch pipe lines. About 7 miles from the compressor there is another 12 inch branch, so that the total length of piping, 20, 12, 6 and 3 inch, will be about 21 miles.

In order to prove that this power would be a great saving over the present cost for compressed air, about 6 months were spent in making exhaustive tests at a number of the larger mines, and the reports were accepted in every case by the managers. The tests showed that mines could save from one-half to one-third by buying their compressed air rather than producing it, and at the same time could receive the air at a constant pressure. In addition to the advantages mentioned, it is to be understood that the air, being isothermally compressed, is, of course, as dry as possible, thus eliminating the troubles arisng from freezing; further, there being no oil used in compression, the compressed air is practically odorless and ventilates the working faces, which is a distinct advantage. The various Cobalt mines will be piped independently of each other and the air will be sold by meter measurement or by the drill unit as a basis. If sold by meter, a rate of 25 cents will be charged for each 1,000 cubic feet of compressed air per minute, the air pressure being 100 pounds per square inch. The company will furnish in this case an automatic reducing valve, meter, and limit valve. When air is sold on the flat rate, the charge will be based on one drill per shift, the charge, however, decreasing with an increasing number of drills. In this case, the power company will supply the reducing and limit valves, no meter being needed.

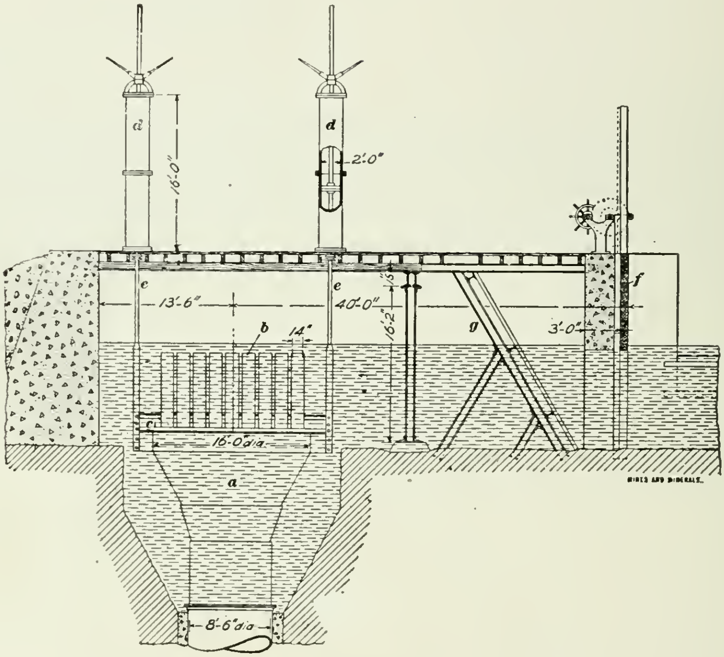


FIG. 2. INTAKE END.

Great care has been taken in the installation of the pipe lines to prevent leaky joints and strains on the pipe. In the 20-inch and 12-inch diameter pipe lines, balanced expansion joints have been placed at half-mile intervals, and half-way between each two expansion joints the pipes are anchored in massive concrete piers to prevent their creeping.

Fig. 1 furnishes a good idea of the general lay of the compressor plant and dam. In the center is shown the gate section, north retaining wall, and part of the spillway. At the extreme right may be seen the outlet shaft. After passing the gates the water flows through two 16-foot diameter intake heads, one of which is shown in Fig. 3 at *a*. In each of these heads there are 66 14-inch diameter pipes *b* set in a steel disk *c*. Below the pipes, the heads gradually diminish in diameter until they become 8 feet 4¾ inches, and from this point they are 15 feet long. In this telescopic form the heads connect with the intake shafts, which are 8 feet 6 inches in diameter and 345 feet deep, with the orifice of the head at the surface of the water. This arrangement permits the heads to be raised or lowered, to conform to the level of the water in the forebay, or the heads may be raised above the level of the water by air lifts *d*, thus cutting off the supply completely. The two air-shift cylinders *d* act as governors, automatically raising and lowering the heads which are suspended from them by the hangers *e*, thereby regulating the flow of water into the intake pipes *b*, according to the demand. The head pieces were especially designed to meet conditions due to extremely low temperatures. The gate *f* is raised by rack and pinion, and there is the usual rack *g* to prevent floating material from entering the head-pipes.

The water, with the entrained air, flows through the heads with a descending velocity of from 15 to 19 feet per second, gradually diminishing in the velocity of fall, owing to the compression of the volume of air; finally there is a further reduction in velocity owing to the enlarged section of the last 40 feet of fall, shown in Fig. 2. By the time the water reaches and strikes the steel-capped concrete diverting cones *a*, its velocity is so diminished by the baffle from the compresed air that there is little shock.

The cones *a* are for the purpose of spreading the flow of air and water, thereby bringing the air nearer the flow through the tunnel. The air being lighter than the water, it rises to the surface of the water under a pressure of 120 pounds per square inch. The tunnel was made 20 feet wide, 26 feet high, and 1,000 feet long, the latter for the purpose of utilizing the total head of the stream, although this length was not necessary in order to give the air time to leave the water before the latter started up the outlet shaft *b*. As the velocity of the water in the tunnel is about 3 feet per second, practically all the air will leave the water in the first 300 feet. The last 75 feet of the tunnel has the height reduced to 16 feet.

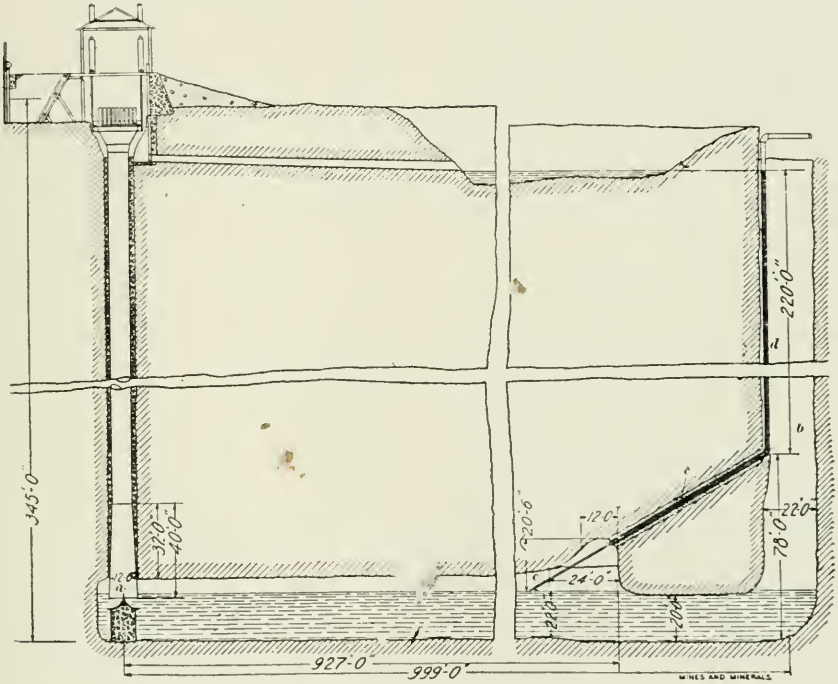


FIG. 3. DIAGRAM OF COMPRESSING PLANT.

The pressure given to the air is due to the height of the body of the water in the outlet shaft, which in this case is 298 feet deep and 22 feet in diameter. The water flows along the tunnel and up the outlet to the river, the difference in elevation between the mouth of the intake and the discharge tunnels being 47 feet. Near the outlet end of the tunnel its height is increased to 42 feet, and at this place two pipes are carried through the 30 degree riser *c* to the uptake shaft. One pipe *d*, 24 inches in diameter, carries the compressed air to the surface, where it is connected with the 20-inch main air pipe line. The other pipe *e* is 12 inches in diameter and has its end submerged at a safe distance above the roof of the outlet portion of the tunnel, to act as a blow-off in case the air in the tunnel should acquire such pressure as to force the water below the level of the tunnel outlet. If the air were allowed to escape up the outlet it would lighten the column of water in that shaft, and the air pressure would not be constant. The blow-off pipe ends at the upper level of the water in the outlet shaft, its end remaining open to the atmosphere. When the volume of air is greater than the demand, the air accumulates in the upper part of the tunnel, forcing the water down and exposing the lower end of the blow-off pipe *e* to the compressed air, thus allowing a portion of the water in this pipe to drop back, thereby decreasing the weight of the remaining water in this pipe to less than the pressure of the air. The equilibrium is now overcome and the water in the pipe is driven upward to the surface, where a most spectacular sight is witnessed, as the body of water is shot out by the air sometimes to a height of 500 feet. The blow-off continues until the pressure of the air in the tunnel is sufficiently reduced to again submerge the end of the pipe. Water now rises until an equilibrium is established between the air and the water pressure in the tunnel. The air pipe and the blow-off pipe are packed in concrete the entire length of the 30 degree riser, in order to seal them in and prevent any escape of air up the outlet shaft. Thus these arrangements permit the delivery of a large body of air at a constant pressure at all times.

FALSE ECONOMY IN AIR CONSUMPTION*

There has been quite an amount of talk about machine air costs, and it seems that some people are as mad about this so-called economy as they are about running three or more machines per man. They do not bother about the half-crown they lose if they can gain threepence in the airs costs. To me it appears that the machine that drills a few feet more per shift is the one to be after, even if air costs are 20 per cent. higher. For instance air costs per machine shift are, say, 6s.; then say 30 per cent. is leakage, etc., leaving 70 per cent. against the machine itself. This equals 4s. 3d. The machine drills 24 ft. per shift and breaks two-thirds of a fathom of ground. Now suppose we change the machine and use one that takes 50 per cent. more air, making the cost 6s. 4d. against the machine itself. Leakage will be the same, and how much more work must the new machine do to pay for its extra cost? To get at this we must know the total cost of breaking ground per fathom. This we will take at say 70s.; even with the three machines per man, 70s. equals 46s. 8d. per shift, equals 1s. 11.3d. per foot, so to pay for the 50 per cent. increase of cost of air for the machine we only need another foot of drilling from the machine, despite all the worry about getting a machine to save air. I think looking at the air costs alone is wrong if we really wish to lower the machine costs. The same reasoning applies to whatever machines a mine may be using. Do not worry particularly about the cost of air per machine shift, but to the cost per fathom, and strive to get the best from the air.

Do not let your machines get into the rattletrap stage, but spend money on keeping them in order. If one machine fitter has a hard job to keep the machines in fair running order, have two and keep the machines in good order, the total cost being the point to watch. Let any individual item rise if by so doing the total is lowered. We have at the present time some very good drilling machines on the Rand, but we do not get the work out of them that they are capable of doing. It is well known that there is a very great difference betwen the lowest and highest cost per fathom on any mine. I figure it that some men can do fairly well on three machines and others cannot. Why then give the poor man three machines? Give him the same price per fathom and let him try fewer machines. I have often seen men make as much money stoping with one machine as with two, the same price per fathom being paid.

The moral is: get a machine that can drill, and a man at the back of it to see that it does drill. Then machine costs will come down even if air costs are higher. Some use the argument that if a machine uses less air we can use more machines with the same compressor plant, but I say, get the same footage from a smaller number of machines even if each takes more air. Money is saved, because there are less machines to buy and less machine men required, leaving us the chance of keeping out some of the men who have not yet learned their business.

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*Tom Johnson, in Journal of Chemical, Metallurgical and Mining Society of South Africa.

THE HISTORY OF THE ROCK DRILL AND OF THE INGERSOLL-RAND COMPANY

BY W. L. SAUNDERS.

The percussion rock drill, as distinguished from all other types, is an American invention, the first practical patents having been taken out by J. J. Couch of Philadelphia in 1849. Couch was assisted in building this drill by Jos. W. Fowle, later of Boston, their experiments being carried on during the year 1848. The Couch drill was a crank-and-fly-wheel machine, and its application to practical work was therefore limited to surface hole drilling.

In 1848 Couch and Fowle separated, Fowle filing a caveat in 1849. This caveat describes the type of successful power rock drill used to-day. The chief point was that Fowle first showed a drill where the cutting tool is attached directly to the piston or to the crosshead connected with the piston. In other words, the bit leading into the hole was an extension of the piston rod. This important invention was described by Mr. Fowle, in his testimony before the Massachusetts Legislative Committee in the contest with Burleigh in 1874, as follows:

"My first idea of ever driving a rock drill by direct action came about in this way: I was sitting in my office one day after my business had failed and happening to take up an old steam cylinder, I unconsciously put it in my mouth and blew the rod in and out, using it to drive in some tacks with which a few circulars were fastened to the walls."

The nearest approach to rock drill inventions abroad was in the German work of Schumann, in 1854. Fowle being without means, but a genius in the true sense, his inventions remained in obscurity until Charles Burleigh purchased his patents and produced the Burleigh drill, about the year 1866. This drill was used in the Hoosac Tunnel in 1867. Following these inventors came Haupt, De Volson Wood, and Simon Ingersoll, and after these were Sergeant, Waring and Githens, Githens being the inventor of the Rand Drill.

The Ingersoll drill was invented in 1871.

Simon Ingersoll, an ingenious, modest and honest mechanic, came to New York from Connecticut. Having a very fertile mind, he had conceived several inventions, models for which he made with his own hands. While riding in a horse car in New York, and being of a very confiding and loquacious disposition, he described to a fellow-passenger the merits of one of these. One of the passengers in the car who overheard the conversation was John D. Miner, a contractor, who had a gang of men at work upon rock excavation in what was then the upper part of New York. Miner broke into the conversation by asking Ingersoll why he didn't invent a rock drill, something practical, something useful, instead of spending his time and his genius upon "such traps." Ingersoll asked him what he meant by a rock drill and what he wanted to do. Miner's reply was that he had a gang of men at work on the rocks in New York striking steel with a hammer in order to make a hole for blasting; that they could only do about 10 feet a day; and that he couldn't see why the work could not be done by machinery. Ingersoll said he could make a machine to drill the rock and would go at it at once if he had the money. Miner then and there gave him $50.00, together with his card, telling Ingersoll that, though he had never met him before, he had an honest face and he would trust him to spend that $50.00 in building a rock drill. "When you want any more," said Miner, "come to me and I'll give you another fifty."

Ingersoll made his drawings and models and built his first rock drill at a little shop on the corner of Second Avenue and 22nd Street, this shop being owned by Mr. J. E. de Navarro, who operated it under the management and title of Sergeant and Cullingworth. Mr. Henry C. Sergeant came into the works one day and saw the patterns for the drill. The front head was attached to, and was a part of, the cylinder. Mr. Sergeant's fertility in invention was here shown when he very promptly told the men at work that the head and the cylinder should be in two pieces, and of his own accord he took a hand saw and was in the act of separating them in the pattern when the inventor Ingersoll arrived. "What are you doing?" said Ingersoll. "I'm making this thing practical," was Sergeant's response as he finished sawing off the head before Ingersoll could stop him. The result was the first row between Ingersoll and Sergeant, which afterwards resulted in Sergeant's inducing Mr. Navarro to purchase all Ingersoll's rights and patents; and the drill was made with the detached front head, as it is made today.

The success of the machine was soon apparent, and after Mr. Navarro had purchased the patents he organized a company called the Ingersoll Rock Drill Company, putting $10,000 in the enterprise. Mr. Sergeant was now in full control and through him many very important improvements were added. Litigation arose at once with Mr. Burleigh of Massachusetts, who owned the Fowle and other rights, but through Mr. Navarro's plentiful command of funds and his liberal nature, the suits were settled and all the fundamental patents were placed with the Ingersoll Company.

The $10,000 which started the drill business was shortly afterwards paid back to Mr. Navarro. In later years he sold his rights for $525,000. Mr. Sergeant having sold out because of friction with the management, went West, engaged in mining, lost his money and returned to New York about the year 1885 starting the Sergeant Drill Company.

Addison C. and Jasper R. Rand had early become interested in rock drills through their connection with the Laflin and Rand Powder Co. Addison C. Rand formed the Rand and Waring Drill and Compressor Company, later controlled entirely by Mr. Rand and merged into the Rand Drill Co., established in 1871 and incorporated in 1879.

J. C. Githens, manufacturing superintendent of the Rand Drill Company, was the inventor of the "Little Giant" rock drill and also of the double screw column with column arm, which made practical the application of the rock drill for mining and tunneling.

The Sergeant & Cullingworth Company, a manufacturing concern engaged in building the Ingersoll drill, the Sergeant Drill Company and the Ingersoll Rock Drill Company were merged into The Ingersoll-Sergeant Drill Company, and later on the Rand Drill Company was added to this amalgamation, forming the Ingersoll-Rand Company. The Rand drill had from the beginning been the most formidable competitor of the Ingersoll. The conjunction of the two concerns was a combination ot valuable patents in rock drills, air compressors and general mining, tunneling and quarrying machinery. Each shop received the benefit of the experience of the other, and the best points in Ingersoll and Rand types were taken to improve the product. The present company, which has a capital of $10,000,000, sells its product throughout the world; it is the recognized standard in its line, the volume of business is larger than that of any other concern producing this class of product, and it has always endeavored to maintain its standard up to and in advance of the times.

A NEW RECORDING CLINICAL THERMOMETER

Consul-General John L. Griffiths sends an account of a new clinical thermometer which is exciting much interest in British medical circles. The thermometer consists of a very fine flattened coil of platinum wire, 1-250th of an inch in diameter, wound on a thin strip of celluloid film. This coil is then covered, for the purposes of insulation, by a second thin film of celluloid. The ends of the platinum wire are connected with ordinary copper flexible electric light leads. An extremely sensitive galvanometer, which will instantly record any increase or decrease in the amount of electric current passing, is let into the circuit. The leads then pass to an electric recorder, on which the extent of the variations in the current passing are noted by an upward or downward swing of an ink-tipped pointer traveling on a continuously revolving paper-covered drum or cylinder. The principle underlying the thermometer is that any change in temperature of the coil of platinum wires will vary the amount of current which can pass through it, this change being determined by the galvanometer and recorded on the revolving drum. The thermometer, which is in an insulated celluloid case, is to be placed in the arm pit and kept in position by a bandage which will pass over the opposite shoulder. The arm will also be bandaged to the side in order to protect the thermometer from all atmospheric influences. It is expected that this new instrument will be used chiefly in hospitals in the treatment of such diseases as typhoid fever and pneumonia.

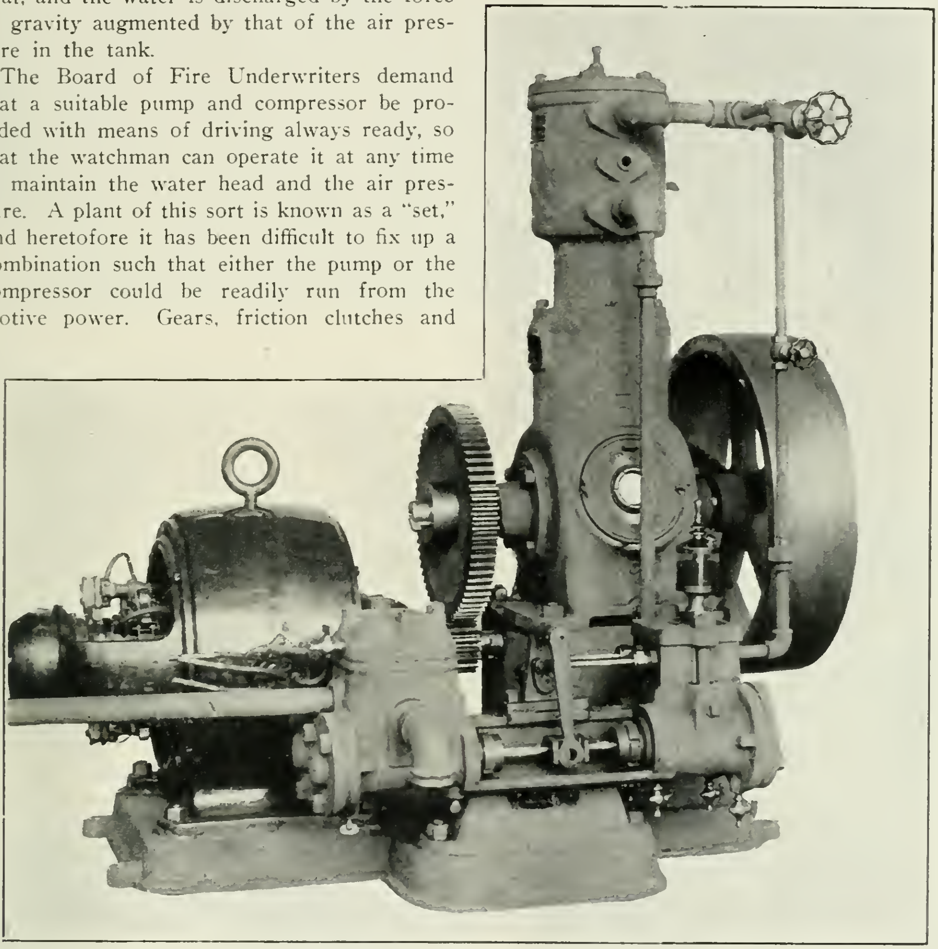
AN AUTOMATIC SPRINKLER "SET"

The half tone shows an interesting electric, pneumatic, hydraulic combination which is proving highly satisfactory for the special purpose it is designed for. It is the responsible and actuating member of an automatic sprinkler system as installed in many buildings in San Francisco and elsewhere in compliance with the requirements of the Board of Fire Underwriters. In the system of which this apparatus may be assumed to be a part, there is a tank upon the roof holding, say 6,000 gallons, more or less, which normally is filled two-thirds with water and one-third with air at a pressure of, say, 75 pounds. Then from this tank pipes lead along the ceilings of the various rooms with sprinkler heads located where they may be expected to be most effective in case a fire starts. These heads are plugged with a material which melts at a low heat, and the water is discharged by the force of gravity augmented by that of the air pressure in the tank.

The Board of Fire Underwriters demand that a suitable pump and compressor be provided with means of driving always ready, so that the watchman can operate it at any time to maintain the water head and the air pressure. A plant of this sort is known as a "set," and heretofore it has been difficult to fix up a combination such that either the pump or the compressor could be readily run from the motive power. Gears, friction clutches and change mechanisms which have been tried have been expensive and unsatisfactory. The "set" here shown seems to simplify the proposition. The motor drives the compressor and the air compressed is partly used to drive the pump and partly goes to maintain the air supply in the tank. All the air compressed and also air from the tank may be used to drive the pump if circumstances require it. The exhaust from the pump returns to the compressor, and as its temperature is lowered by the work it does, this is an economical feature.

With the motor and compressor running at constant speed the throttle in the compressed air pipe heading to the pump controls the proportions of water and of air delivered to the tank. If the pump is run slowly there will be a surplus of air going to the tank, or if the pump is run at more than normal speed it may take not only all the air delivered by the compressor, but also some from the tank. In that case the tank could spare some air without loss of pressure as the inflow of water from the pump would be reducing the air space.

The "set" as here shown weighs 850 pounds with alternating current motor, and 1,050 pounds with direct current. The arrangement is the invention of Mr. E. A. Rix, president of the Rix Compressed Air and Drill Company, San Francisco, Cal.



BIG AUTOMATIC SPRINKLER SET

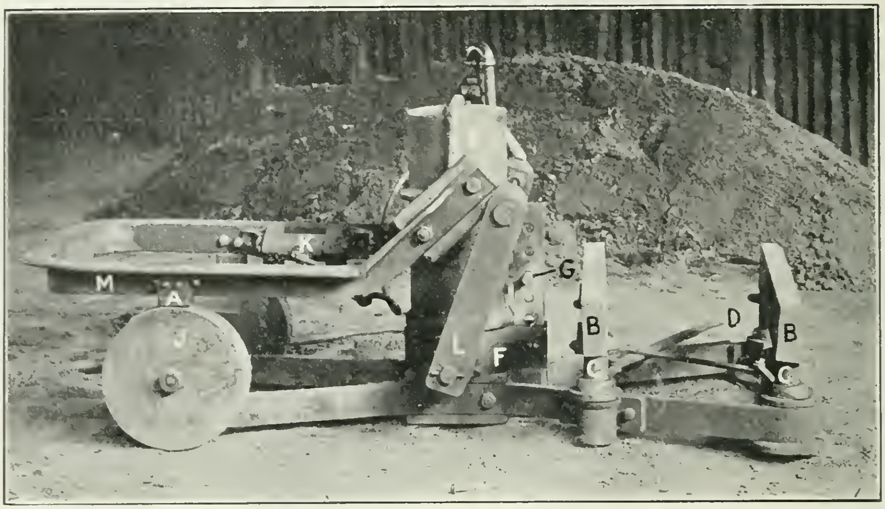


FIG. 1.

NEW FARWELL PNEUMATIC ROLL-OVER MOLDING MACHINE

From the series of half-tones here presented we may obtain a clear understanding of the construction and operation of the above machine. As will be seen, it jolts the mold, turns it over and draws the pattern, the jolting being equivalent in effect to, and thus dispensing with, the operation of ramming, doing the work more satisfactorily and much quicker. The combination of these features in a portable machine is said to be new.

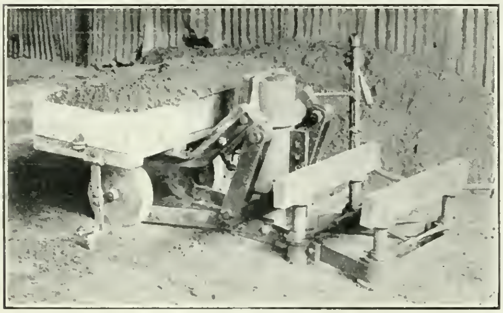


FIG. 2.

Fig. 1 shows the machine entirely bare. The base or frame has two heavy, solid cast iron wheels J which run upon a track embedded in the floor, thus affording an ample foundation at small expense, and without requiring a permanent locating of the machine in any particular spot. The wheels are made so heavy to serve, as will appear, as an anvil for the jolting.

The machine is of course actuated by compressed air. In the center of the base is fixed a vertical trunk piston or plunger upon which works an inverted cylinder E, on the sides of which near the middle are projecting trunnions which serve as pivots for the angle iron frame M, which carries the molding flask. At the beginning of operations the heavy iron blocks *A* fastened to the frame M rest upon the wheels J on each side. Inside the frame as it rests on the wheels in Fig. 1 is seen the Adam's pneumatic rapper K which frees the pattern in the sand before and during the drawing.

In Fig. 2 we see better how the castings

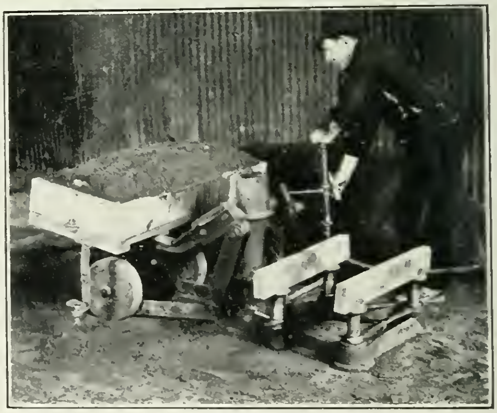


FIG 3.

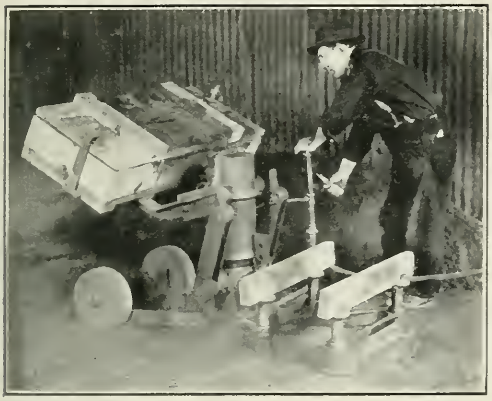


FIG 4

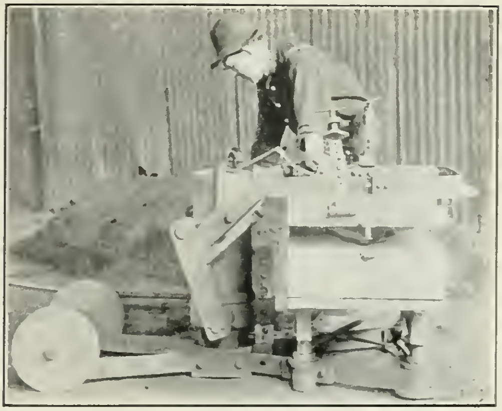


FIG 6

which carry the angle iron arms are pivoted on the cylinder. These castings have heavy lugs which form the short arms of levers for lifting the frame M and the flask placed upon it, the connections L being attached to these lugs, the lower ends of the connections being pivoted to the movable yoke F. When air is admitted to cylinder E frame M rises vertically with it until yoke F strikes pin G inserted in one of the holes of the upright according to the requirements of the particular job. When yoke F strikes pin G, the cylinder continuing to rise, then the frame M begins to tilt for rolling over the flask.

In Fig. 2 the match board has been attached to frameM—this match board with the pattern is seen clearly in Fig. 8—a flask has been placed upon it and filled with sand ready for jolting.

Fig. 3 shows the operation of jolting, which is accomplished by admitting air to the cylinder and exhausting, both of which operations are controlled by the same valve. The experience of the operator determines the number and force of the jolts required.

After jolting and striking off, the bottom board is placed in position and clamped, Fig. 4 showing the flask being turned over. This is done by admitting air until cylinder E rises to its highest position, the operator perhaps assisting the flask as it passes over the center, and then on slowly releasing the air the flask descends until in Fig. 5 it rests upon the cross-pieces B. These cross-pieces rest upon the four plungers C which are provided with springs which automatically equalize or adjust themselves to the irregularities of the bottom board on all four points, and as soon as the

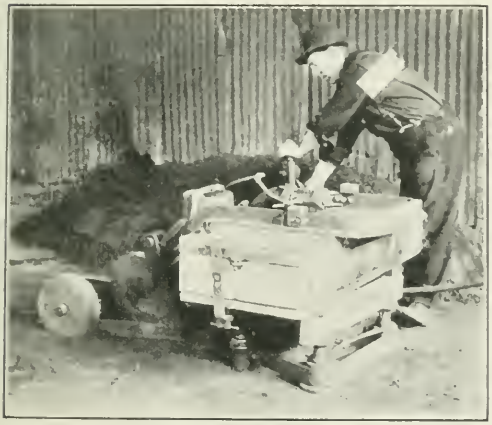


FIG 5.

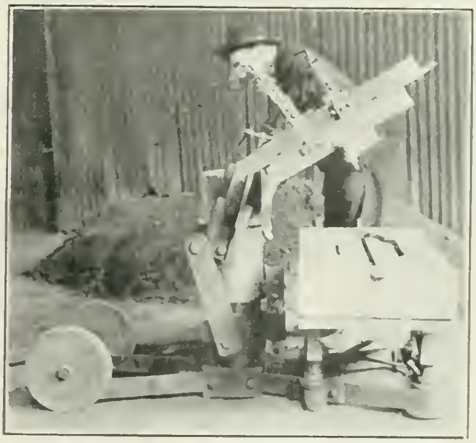


FIG. 7.

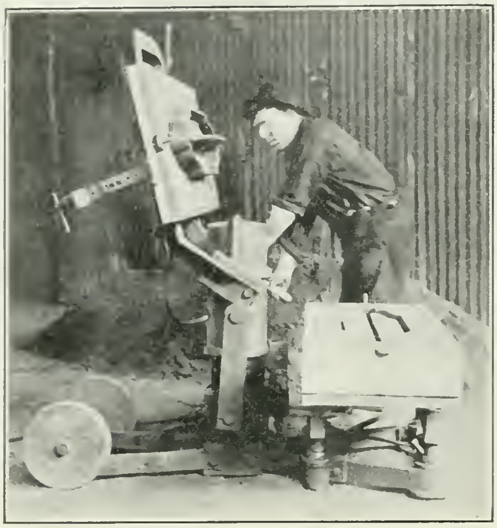


FIG. 8.

mold rests fully upon the cross-pieces the plungers are locked in position by a single movement of the lever D, which is connected by links to all four plungers. This lever may be kicked into locking position by the foot. The molder then releases the flask clamps and is ready to draw the pattern.

This operation is shown in Fig. 6. The molder with his right hand operates the air valve which admits air to the main cylinder, and with his left hand he opens a pet cock, admitting air to the pneumatic rapper. The pattern is drawn vertically to any desired height, which is determined by the placing of the pin G in one of the holes of the upright bar, before starting to roll over, and this combined with the pneumatic rapper and the steady air control gives a good, clean lift.

Fig. 7 shows the position when beginning the rolling over and Fig. 8 after the match board has passed the dead center and is descending to its original position, ready to receive another flask and start another mold.

The tunnel on the Jungfrau mountain line is being driven at the rate of 10 to 12 feet per day. The line is expected to be opened to an elevation of 11,090 feet in the spring of 1912, and will eventually be carried to 13,670 feet, or only 242 feet below the summit.

DANGEROUS OXY-ACETYLENE APPARATUS

It will be remembered that in the issue of Compressed Air Magazine immediately preceding this we printed an account of a fatal explosion of an oxy-acetylene apparatus in New York City. The following letter sent out by Mr. Augustine Davis, President of the Davis-Bourmanville Company, it will be seen, carries suggestions bearing upon that catastrophe, although not specifically referring to it.

If the union of oxygen and acetylene did not produce an unusually powerful agent, the oxy-acetylene process would not have its present value. Acetylene is by far the richest of all gases in carbon, and combined with oxygen, produces much the hottest flame that has yet been created. It is generated from calcium carbide, which is nothing more than coke and lime combined at a very high temperature, but the finished product is as inert, and as little dangerous, as crushed stone, unless put in contact with water, and it can be subjected to any kind of rough usage without the least danger. Acetylene itself, can not be ignited without a mixture of air, or oxygen, unless it is compressed to more than thirty pounds pressure.

Chemically, oxygen is made from chlorate of potash, and similar materials, which are not dangerous unless placed in contact with carbonaceous matter, so that neither carbide, acetylene, nor the chemicals, are at all dangerous if they are properly handled; improperly treated, they can be made exceedingly dangerous, just as can ordinary coal, or water gas, or any of the hydro-carbons, such as gasoline, or oil.

The present acetylene generator is the evolution of various types that have been tested by years of use, and most of the earliest processes have been discarded by responsible manufacturers. Hundreds of thousands of acetylene generators are in use in the United States, and have become so important in the lighting industry, that they are the subject of yearly inspection by a body of engineers, in a laboratory which has been established by the National Board of Fire Underwriters. These engineers have become experts in the generation of acetylene, and have prescribed rules for the construction of such generators, which are the outcome of years of constant examination of apparatus of this character.

Generators built in accordance with these rules, can be accepted by the public as desirable types.

These engineers, and the experience of a number of reputable manufacturers, have demonstrated beyond question, that what is known as the carbide-to-water types, are most desirable for the generation of acetylene. Carbide has what is termed "endothermic heat," which is similar to the heat of lime when slaking, only the heat is much greater. One pound of carbide will boil six pounds of water; consequently the engineers for the insurance underwriters have a rule, requiring one gallon of water for each pound of carbide, which, it will be apparent, is sufficient to insure cool generation.

The types generally discarded are known as the water-to-carbide generators. The methods employed in this type were to sprinkle water on the carbide, or to flood compartments, or were of the recession type, where the water rose to the carbide and was forced back by the gas generated when the water came into contact with the carbide. All of these types are objectionable, because there is not a sufficient supply of water present for proper chemical reaction, and it is entirely absent so far as cooling is concerned. The result is that more or less gas is polymerized, or turned into tar vapors, by the excessive heat evolved locally, making a poor gas; and with rapid generation, there is danger of the heat becoming so great as to melt the portions of the generator in contact with the carbide, and to create danger of explosion should the generator be opened when the carbide is in this heated condition. Generally, the carbide is in the interior of the generator, surrounded by water, so that the heat is not perceptible from the outside of the generator, but it exists nevertheless.

Attracted by the supposed profits in the sale of oxy-acetylene apparatus, a new crop of generator makers, who are either unfamiliar with the established methods of generation, or unscrupulous, are springing into existence, and are placing these undesirable types on the market. They are doing exactly what was done with lighting generators, in the earlier part of their history, until there became a great class of what was known as "tin can" machines, the poor results from which it took years of strenuous efforts by the better class of makers to overcome. These types of generators are even more objectionable for oxy-acetylene welding than they were for lighting purposes, because the gas consumption is much more rapid, multiplying the bad effects from this improper generation. Should such generators be subjected to the inspection of the insurance engineers, they would unquestionably be promptly rejected.

Bad as is this method of gas generation, a still worse condition exists. It is known to those who are at all familiar with acetylene, that when it is compressed to from 30 to 45 pounds, or more, there is a kind of disintegration of the molecules, causing the gas to be explosive in the presence of a spark. In the early history of the art, some terrific explosions occurred from compressing acetylene in this form, and for a time its use under compression was entirely abandoned. Through a French discovery it was learned that if cylinders were completely filled with a porous material, and this material was then saturated with acetone, the acetone would dissolve the gas to twenty-five times its own volume for each atmosphere of pressure, and that when the pressure was relieved the acetone would give off the acetylene, and that this method not only gave the cylinders a marvelous capacity, but made it entirely safe to use acetylene in this form. The "Presto-o-lite" cylinders, which can be found on almost any automobile, are examples of what has been done in this line, and many railroad cars are lighted by this system. It is also employed quite extensively in oxy-acetylene welding for portable uses.

In the face of past disastrous experience, there are persons who are manufacturing acetylene by compressing it direct from carbide, without purification, and during the past year there have been several fatal accidents from this cause. In one case nine people were killed, and the directors of the International Acetylene Association held a special meeting, and passed resolutions condemning this process, which it is nothing less than criminal to employ.

A method is being used to make apparatus portable, which is nothing more or less than to place an acetylene generator on an ordinary truck, and wheel it about. A generator in this position is not only likely to be accidentally tipped from the truck, but it may be placed in close proximity to red-hot furnaces, or struck by swinging cranes, or injured in many other ways, and it does seem as though any careful, thoughtful person could immediately realize the danger of such an arrangement. If the generator should be tipped over, it would immediately bring the whole body of water and carbide into contact, which would certainly burst the generator, and the volume of gas released might come into contact with fire, and an explosion follow. Obvious as is this danger, there are men in important mechanical positions to whom it did not occur until their attention was called to the possibilities. Certainly, no intelligent insurance representative would approve of such apparatus.

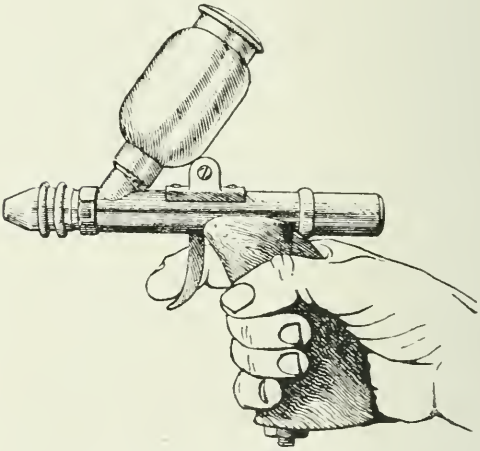
So far from acetylene being considered dangerous, when properly manipulated, the highest insurance authorities have concluded that it is much safer than movable units, such as lamps; and there is no reason why it should not be equally safe for oxy-acetylene purposes.

The conditions with regard to the generation of oxygen, are not much better. The desire of many persons, who can use the oxy-acetylene welding process to advantage, to obtain apparatus at very low cost, has proved to be a great incentive to constructing the apparatus cheaply.

Oxygen has been produced in this country for many years from chlorate of potash, and similar chemicals, but in such cases it has been the practice of the most prominent manufacturers to generate this gas under only sufficient pressure to wash it thoroughly, and force it into a gasometer, from which it is compressed by a compressor into tanks for portable use. It does not require much thought to realize that it would be much cheaper to generate the oxygen in the retorts, under sufficient pressure to force it into the tanks ready for use. This would cut out large washers, the gasometer, and the most expensive part of the plant, the compressor; such a plant could be built at small cost, and at considerable profit. That this is being done, and advertised quite extensively, requires only the examination of the advertising columns of a number of trade papers to show.

The most approved types of plants generating oxygen from chemicals, have the compressors built with two stages of compression, with an intercooling coil between the cylinders, and with the cylinders totally submerged in water, so that even though there are impurities in the gas, there is not sufficient heat generated to ignite the mixture. It is also required that the parts of these compressors subjected to oxygen must be of non-corrosive metal, which adds still further to their cost. It will be evident that plants not having these necessary requisites can be, and are, sold for much less than properly constructed apparatus.

Defective and dangerous types of oxy-acetylene apparatus have not, as a rule, given satisfactory results, and they thus tend to discredit the process. Such apparatus has injured the art not only in this country, but in Europe as well. Solicitations have been received by the company which the writer represents, to sell its apparatus in Austria, by a very prominent firm, whose letter states that that country has numerous cheap and ineffective plants, which have brought the process into disrepute.



PAINTING WITH A PISTOL

The cut, from *Popular Mechanics*, shows a fountain air brush for either the fine work of the artist or for painting large surfaces. The paint is contained in the holder above the barrel, and compressed air conveyed by a tube presses up through the handle into the barrel where it picks up the paint and sprays it onto the surface to be painted. The tool is made in several sizes, ranging from the fine needle point apparatus to those used for painting vehicle bodies and the like.

DRYING AIR BLAST WITH CALCIUM CHLORIDE

Two French Metallurgists, M. M., F. Daubiné and E. Roy, have succeeded in developing a cheap and efficient process for drying blast furnace air by means of calcium chloride. They were attracted to the problem by the success of the Gayley refrigerating process. In a blast furnace with an output of 130 tons per day, using moist air, it was calculated that by drying the air the output could be increased to 150 tons, and at the same time the cost of production could be reduced by from 40 to 60 cents per ton. For a plant of this size the expense of installing a refrigerating plant would be at least $60,000, and the operation, maintenance and depreciation cost would be very close to 40 cents per ton.

Calcium chloride, the cheapest, most active and most easily handled hygroscopic material, is capable of retaining at least as much water as is extracted by the refrigerating process, and regeneration when saturated requires only the application of heat. The hygroscopic power of calcium chloride is greater at low temperatures, so that it is necessary to effect the drying before the air goes to the blowing engines. Further, as the material becomes heated in the process of absorbing moisture, the grating upon which it is carried must be cooled by the circulation of cold water. The rate of absorption falls as drying progresses, hence the speed of the air passing through the mass must gradually decrease, necessitating a gradual increase in the sectional area of the dehydrating mass. The hydrated mass formed on the surface of fragments of calcium chloride is fluid and has a tendency to run, and the air must be passed downward so that what becomes fluid enough to flow will be caught and held by the less hydrated portions below. The calcium chloride must be protected against contamination, so that if furnace gas is to be used to regenerate the spent material, it cannot be allowed to operate directly on the surface of the chloride on account of the danger of dust being deposited in such quantities as to destroy the hygroscopic power of the substance, and also there is a considerable risk of converting a portion of the chloride into carbonate by the action of carbon dioxide.

The new process here spoken of takes account of all these things. Each apparatus is composed of ten similar and superimposed units, measuring about 10 feet square and 16 inches in height. Each unit has three elements: (1) a grating of water-cooled, externally ribbed tubes, which carries the calcium chloride; (2) a series of tubes, triangular in section, imbedded in the chloride and resting on the grating on one of their edges, through which furnace gases are passed; and (3) two flat sheet-iron chambers, one located at the moist-air intake, the other at the dry-air outlet.

The air to be dried is impelled by a fan into a conduit, whence it is distributed among the intake chambers, and from these chambers it passes into the various units of the apparatus. The air then passes downward through the mass of the chloride, which offers to the air a gradually increasing section, as the free air space between the triangular tubes for the heating gases increases progressively downward, from 58 square feet at the top to 97 square feet at the bottom. The dried air passes into another collecting chamber, whence it is led to the intake of the blowing engine.

In the regenerative process the hot gases are led from the flue into a distributing chamber, whence they are distributed among the different sets of triangular tubes. After passing through the tubes they enter another chamber which communicates either with a chimney or with an exhaust fan. During the passage of the heating gases through the triangular tubes a second fan draws through the chloride a regenerating current of air in a direction opposed to that of the air going to the blowing engines. By regulating the speed of this fan, the temperature of the mass of chloride can be adjusted to effect progressive heating, and it can be prevented from rising above 235 degrees C., the maximum limit.

The type of apparatus described is especially suited to works where no surplus motive power is available and where it is necessary to utilize the heat of the furnace gases in the most efficient and economical manner. In plants which have a large surplus of furnace gases, as is the case in many ironworks producing pig iron alone, it may be more economical to waste the furnace gases used in the drying process for the sake of obtaining convenience of construction and facility of operation of the drying apparatus. For such plants MM. Daubiné and Roy propose a second and simpler form of apparatus. The triangular heating tubes within the mass of the chloride are omitted and the units of the drying apparatus consist of only the water-cooled grating and the hygroscopic material. The drying of the air is effected in the manner already described, but the regeneration of the chloride is carried out by a different procedure. The drying air from the secondary fan is passed through an apparatus resembling a Green economizer. The air flows through a series of externally ribbed tubes surrounded by hot furnace gases or by a similar heating medium. Heated thus it is drawn upward through the mass of spent chloride. At the temperature at which the air leaves the economizer (235 degrees C.) it is capable of absorbing very large quantities of water vapor and acts on the chloride both as a heating and as a drying agent. One economizer is provided for the four drying units of each blast furnace and operates continuously, the hot air being drawn into each unit in turn, as occasion requires.

The researches of MM. Daubiné and Roy have been carried out on an experimental apparatus with an output of 3,500 cubic feet of air per hour. Under average conditions it has been found that the calcium chloride easily dessicates ten times its own weight of air. Allowing a margin of 100 per cent. on the quantity of chloride required, the first purchase will not exceed 25 long tons, at a cost of $500. The total cost of the equipment for each furnace, including the 30 and 20 horse power fans will not exceed $10,000. The material being non-volatile, the waste of calcium chloride must be small. The apparatus would require the attention of only one man per shift, and the power and labor costs would be small, not more than $11 per day. Including an allowance of 4 per cent. for depreciation, the total estimated cost for a furnace with a daily output of 150 tons is $24.40 per day, or 16 cents per ton. The refrigerating process, with the machinery required, costs 39 cents per ton.

Columbus, Ohio, now has a natural gas supply from West Virginia. The line is 85 miles to the Ohio connections, has three Ohio River crossings and is capable of 20,000,000 cubic feet per day. The same main will supply Cincinnati, Hamilton, Springfield and other cities.

TWO COMPRESSED AIR MINE LOCOMOTIVES

The half tones on the opposite page show us two interesting compressed air locomotives recently built for mine service by the Baldwin Locomotive Works. Both these engines are of the four coupled type, but they differ from each other more than the half tones suggest, both in size and in many constructive details.

The locomotive for the Lehigh Valley Coal Company is built within a width limit of 5′ 6″ and a height limit of 5′ 7″, the length over the bumpers being 14 feet. The frames are of forged iron, and they have a slab section ahead of the leading driving pedestals. This construction provides a ready means for supporting the cylinders, which are placed between the frames and are securely bolted to them. The cylinders are set on an incline of 1 in 10, so that the main rods will clear the leading axle. The driving axle of course has two cranks inside and is a steel forging made in a single piece. There are two similar air tanks with a combined capacity of 95 cubic feet. Air is stored in these tanks at an initial pressure of 800 pounds, and a reducer keeps an auxiliary reservoir constantly charged to a working pressure of 140 pounds. Safety valves are provided for both the main and the auxilary resrvoirs at their respective pressures. The equipment includes air brakes for all the wheels, also four sand boxes with spouts to all the wheels. The principal dimensions are as follows:

Gauge, 4′ 0″.
Cylinders, 8″ x 12″.
Driving-wheels, diameter, 28″.
Wheel-base, 4′ 0″.
Tractive force, 3,260 pounds.
Weight, 18,000 pounds.

The locomotive for the Gilson Asphaltum Company, Mack, Colorado, may be said to be about one-half the size or capacity of the preceding. It is lighter and more compact. In the mine where this locomotive is used the air is charged with gilsonite or asphalt dust, rendering it dangerously explosive so that compressed air haulage was adopted as a safety precaution independently of other considerations. The narrowness of the gage permitted only a single air storage tank which has a capacity of 39 cubic feet. The charging pressure is 800 pounds and the working pressure of the auxiliary tank 140 pounds. The frames are of plate steel, supported on coiled springs.

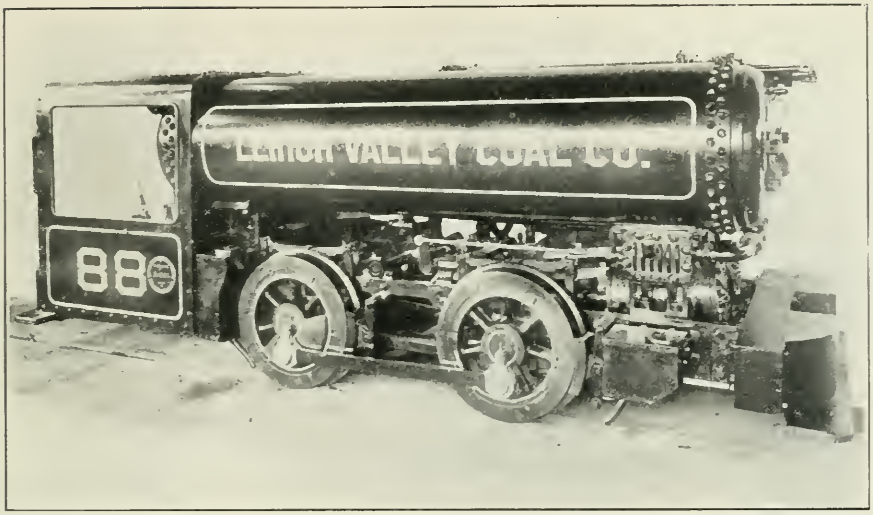


FIG. 1. GAGE 4′ 0″.

The air tank rests directly on the frames, the points of support being over the springs. The cylinders are placed outside the frames in a horizontal position. The function of the heat radiating rings cast around the cylinders is in this case reversed, as the cylinders cool in working and the rings absorb heat from the atmosphere and help maintain the temperature at a workable point within.

This engine is provided with a sand box on each side, and sand can be blown under either front or back wheels. Air brake equipment also is provided with shoes on all the wheels. The auxiliary air tank is placed on the left side and is fitted with a safety valve, as is also the main tank. The nozzle and valve for recharging are seen on the side. The principal dimensions of this engine are as follows:

Gauge, 2′ 6″.
Cylinders, 5½″ x 10″.
Driving-wheels, diameter, 20″.
Wheel base, 3′ 6″.
Weight, 8,650 pounds.
Tractive force, 1,800 pounds.

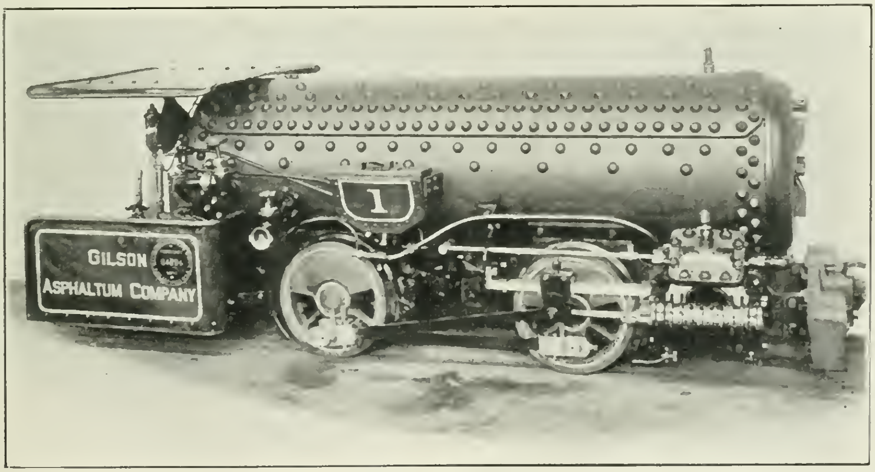
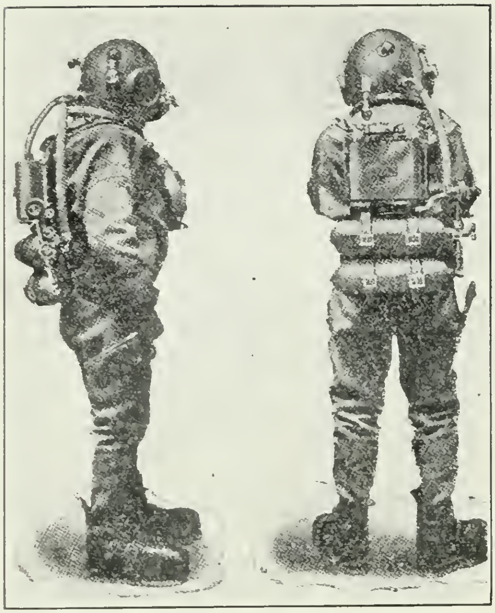


FIG. 2. GAGE 2′ 6″.



DIVING APPARATUS FOR FLOODED MINES

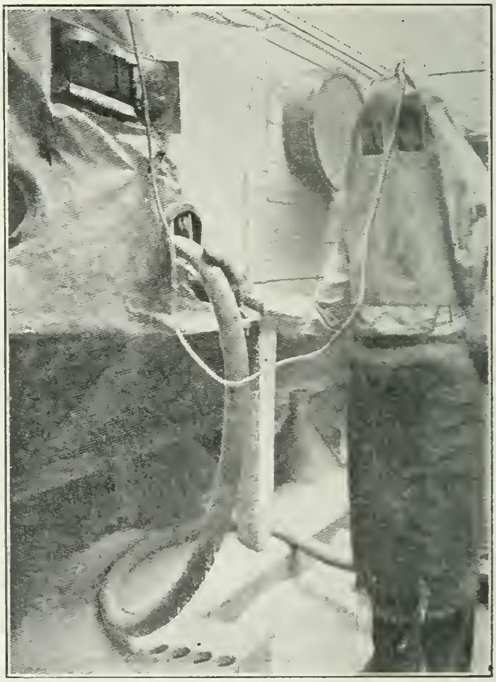
The self-contained diving apparatus shown in the accompanying half tone has been designed more particularly for work in flooded mines and other places where the use of compressors and tubes would be impracticable. It is suitable for work at depths down to 50 ft., the duration of air supply being about two hours at a time. The principle on which it operates is that the wearer breathes the same air several times over, the carbonic acid being absorbed from the exhaled breath and the requisite amount of oxygen restored to it, thus rendering it pure and fit for inhalation again. The apparatus, which is made by Messrs. Siebe, Gorman & Company, Limited, Neptune Works, London, S. E., consists of that Company's patent diving helmet and dress in combination with steel cylinders containing compressed oxygen and atmospheric air in certain proportions, and a metal chamber containing a substance which absorbs the carbonic acid of the exhaled air. Valves are fitted, which allow the air and oxygen to pass into the helmet and dress in the required quantity, no matter at what depth the diver may be working. There is also a safety device, whereby, in the event of a valve failing, the diver would be enabled to supply the requisite amount of air independently of the valves. Any excess of air that accumulates in the dress escapes automatically.

With this dress the ordinary weighted boots are worn, and also a lead weight on the chest, the usual back weight being unnecessary, as the steel cylinders carried there serve the same purpose.

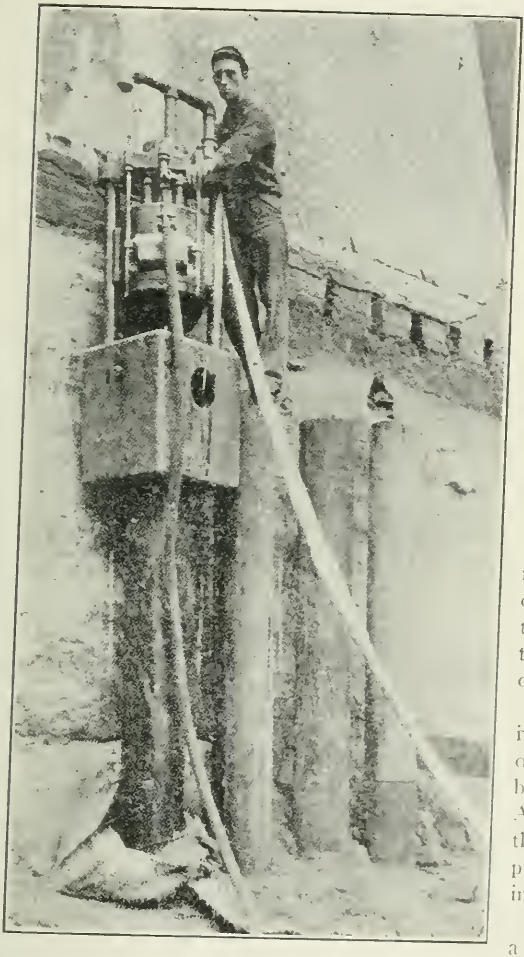
The re-charging of the cylinders of compressed oxygen and air is done from large storage cylinders, and a pump connection for raising the pressure to the full 120 atmospheres in the cylinders of the diving apparatus is supplied. For use in places abroad, or where it may be impossible to get the steel cylinders charged, a portable oxygen-making and compressing apparatus is employed.

PROTECTING THE SAND-BLASTER

The half tone here reproduced from the *American Machinist* shows the operator in the sand blast room of a big automobile factory as he looks when sand blasting cylinder castings. These are behind the canvas curtain through which the hose is run, this being one of the arm-holes through which the operator sticks his arms and directs the sand-blast as he looks through the celluloid window above.



It will also be noticed that he is provided with a substantial hood and that a little hose runs through this which is connected to a low-pressure air supply, keeping the hood free from particles of dust which might be injurious to him. The protective arrangement here shown seems to be the most complete and effective yet brought to our notice, but no precautions which can be devised should fail of adoption if they give any promise of additionally protecting the workmen.



DRIVING FOUNDATION TUBES IN A BASEMENT

In a recent issue of *Engineering Record* from which our half tone is taken, is described the construction of a heavy concrete and steel safe-deposit vault in the basement of an occupied building in Wall Street, New York. The vault is entirely independent of the building structurally, its foundations having been carried through water and quicksand to solid rock, without any injury to the building and without inconvenience to its occupants.

A pit excavation was made for the vault and for a mirrored inspection space entirely suring it, and for the foundations or supports of the vault eight pile tubes were sunk through openings provided in the concrete floor of the excavation. The tubes had an outside diameter of 12¾ in., the metal being basic, open-hearth steel, 3-8 in. thick.

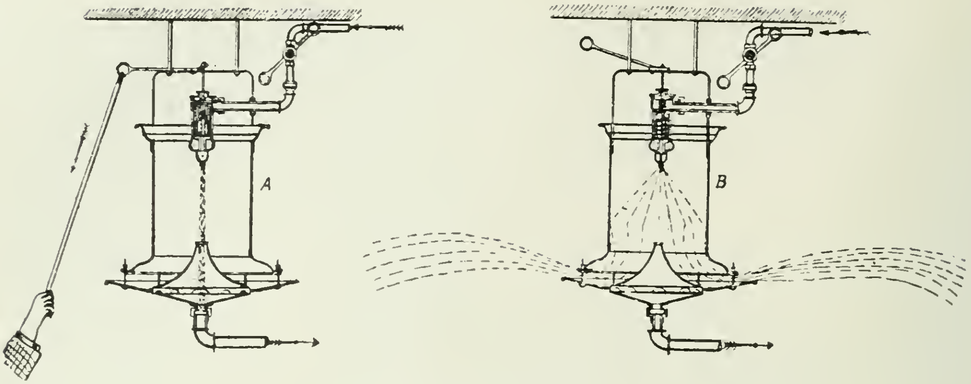
The sinking as shown in the half-tone was done by means of a Clark tubular hammer weighing 4,000 lbs. and striking 160 blows per minute. This was operated by air at a pressure of 100 pounds. As sinking progressed, material was removed from the tube by means of a water jet delivered throughg a 2-in. pipe working freely through the tubular piston of the hammer. The escaping stream of water and sand came out through the base of the hammer into a canvas boot and was delivered to the sump through hose of the same material. The jet was supplied by a Davidson plunger pump, the pressure being 110 lb. The boot was fastened tightly about the pile-tube, thus avoiding the necessity for a tight fit between the tube and hammer. By the time hard rock was reached the tube was free of fine material.

After the eight tubes had been sunk, such small boulders and other solid material as remained in the tubes, was blown out by means of air at 100 lb. pressure, which was discharged through a pipe having its open end at the bottom of the tube. The tubes extended to a depth of about 18 ft. below the cut-off level.

Two tubes were sunk in a nine-hour working day. The actual time of sinking a tube was one hour. The work of cutting off was done by a special machine, containing an air motor. A 1:2:4 mixture of concrete was used in filling the tubes, the stone employed being ¾ in. Each pile was capped by a 22x22-in. ribbed steel casting, having a thickness, above the pile, of 2 in.

The air hammer and tubes were handled by a derrick having a 15-ft. A-frame, and a 30-ft. boom operated by a Dake engine. Steam for the engine, for the Davidson pump and for the Ingersoll-Rand air compressor was furnished by a 100-hp. locomotive boiler, located in the street.

McKim, Mead & White were the architects, and the work was done by Clark & Company, Mr. F. L. Jenkins, Superintendent.



DROSOPHORE HUMIDIFIER.

FACTORY HUMIDIFIERS

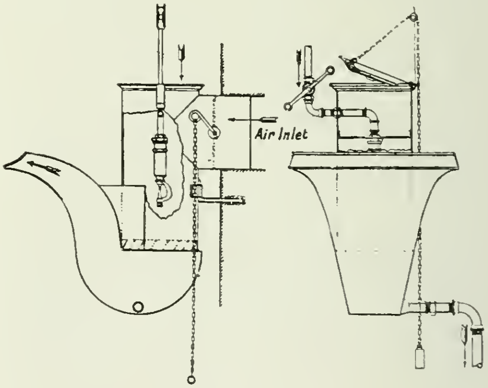
It is well known that a humid atmosphere is a necessity for cotton spinning and weaving. The position of Lancashire in this industry is understood to have been secured chiefly by reason of the moisture in the atmosphere of the district. Even here, however, it has been found highly profitable to increase the natural humidity by artificial means, and we here illustrate two apparatus employed for the purpose.

THE DROSOPHORE HUMIDIFIER.

In the Drosophore system a machine is employed which produces the maximum degree of humidity, washes and purifies the air and gives off moisture in so fine a spray that the atmosphere absorbs it without dripping or wetting the machinery. The fine mist given off is produced by a very simple appliance consisting of a nozzle which is easily cleaned when necessary by the depression of a lever. This nozzle is placed in a cylindrical box about the size of the casing of an electric arc lamp. The casing is open at the top—see Fig 1—and round the bottom, and the action of the water coming through the nozzle is to create a partial vacuum, so that air rushes in at the top, passes through the fine spray, and out at the bottom saturated with a considerable amount of moisture. The illustration shows the appliance in operation and also shows the method of cleansing the nozzle. These appliances are suspended from the ceiling at suitable distances apart, the number required for each room depending upon the class of material produced and certain other conditions. They are supplied with water under a pressure of from 100 lbs. to 120 lbs. by means of belt-driven pumps and galvanized iron piping of small diameter. Each machine consumes from 60 to 80 gallons of water per hour, of which amount between 2 and 3 gallons are dispersed in the air, and the remainder is returned to the main supply tank by means of return pipes, after passing through a filter, in which it is cleansed.

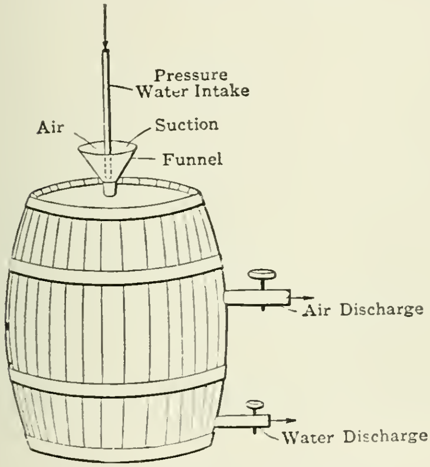
VENTILATING HUMIDIFIER.

Another form of appliance used in this mill in the card room and spinning rooms is the ventilating humidifier, which enables the air brought into the shed to be moistened, washed and purified. A sectional view of one of these appliances is shown in Fig. 2. This is a U-shaped appliance, in which the incoming air has to pass through a water spray produced in a similar way to that in the apparatus above alluded to before being allowed to escape into the shed, where it is delivered in an upward



VENTILATING HUMIDIFIER.

direction. The number of Drosophore machines in the weaving shed is sufficient to give the maximum amount of humidity required, and the ventilation is so arranged that the air is charged so as to have the humidifying installation under control. The humidifying machines in the centre of the room are placed at such distances as to give the requisite moisture, and the air is continually renewed by means of exhaust fans, which draw from the middle of the room. The pumps, which supply all the water for the Drosophore installation are placed in the mechanics' workshop, and are driven by belts from the main shafting. There are two pumps, one for the weaving shed and one for the spinning room, and each has its own system of piping, &c. The humidising apparatus was supplied by the Drosophore Company, Limited, Manchester.



A HYDRAULIC AIR BLAST

A hydraulic air blast is easily rigged up where water under high head is available, and serves quite satisfactorily for affording ventilation, supplying the blacksmith shop, etc. Three holes are bored into a tight, strong barrel, one in the top and two on the sides, as indicated in the accompanying drawing. Into the one in the head of the barrel a funnel is inserted and fitted tightly. Pipes are tapped into the other holes and preferably some sort of valve or spigot arrangement provided on each. A smaller pipe connected with the water supply opens into the funnel, the end of the pipe being set a couple of inches above the throat of the funnel.

On turning on the pressure water, air is entrapped and forced into the barrel. The lower pipe serves for an outlet for the water and the upper one as an air discharge. By regulating the valves on the discharge pipes so that the water is let out as rapidly as it enters, and setting the end of the pressure-water pipe at the proper height above the throat of the funnel, a strong air blast can be maintained. The amount and pressure of the water admitted regulate the amount of blast obtained. On the 800-ft. level in the Pittsburg mine near Nevada City, Cal., such an arrangement is used with great success, water being taken from the pump column to operate the blast.—*Engineering and Mining Journal.*

GRAPHITE FOR AIR CYLINDERS

The following letter was addressed to the editor of *Graphite*, from whose page it is here reproduced:

For the past ten years I have been using flake graphite on the air end of an air compressor and I want to tell you about it. When they started to put in this air compressor and I found out I was to have charge of it when installed, I read up on air compression. I soon learned that oil is a poor lubricant for the air end, even though the terminal pressure is low. But in this case it was necessary to have a temporary pressure by gauge of 120 pounds to start the column of water in the air lift system, and I found out by reading, that at this pressure the air is nearly at the melting point of lead, which is about 620 degrees Fahrenheit. I at once determined that as soon as the machine was turned over to me, I would use flake graphite, with as little oil as possible; for the very best of oil, I care not if it is valve oil of the highest quality, is a poor lubricant for air cylinders carrying 90 pounds gauge pressure or over.

This machine had been in use at another place when new, and had been taken out and placed in my charge after about six months use. At the first opportunity I took out the discharge valves and found them heavily coated with a deposit of carbon. These I cleaned of all deposit. I then turned my attention to the cylinder. On taking off the cylinder head I had found the inside of the cylinder scored in places, and looking very dry. I cleaned everything nicely, and made a dope consisting of a good quality of cylinder oil and Dixon's Flake Graphite, which I applied to the walls of the cylinder. I have now been running this air compressor eleven years. A few days ago it was taken out and sent to the shop for general repairs. This is the first overhauling the machine has had in that time. I have used Graphite on all bearings of the machine as well as in the air cylinder. The air cylinder is in perfect condition, there are no signs of scratches or cutting, it is in as perfect condition as when started eleven years ago. There has been little deposit of carbon; not as much in ten years, as in six months when only oil was used in the air cylinder.

This is my plan of employing Flake Graphite in the air cylinder. Three times a week I take out the inlet valves, which are of the poppet type, and clean the same. Before returning to place, I take out a small quantity of flake graphite and mix with valve oil to make a thick dope. I then take a stick with a piece of rag wrapped around it to make a swab, dip it in the mixture of flake graphite and cylinder oil, and coat the inside of the cylinder. Between the intervals of cleaning the inlet valves, say three times a week, I allow the machine to inhale about a teaspoonful of dry flake graphite three times a week for a run of ten hours a day.

The piston rod on the air end has a beautiful polish, and does not show a wear of more than a good 1-32 of an inch in the eleven year run. In packing this rod, I have used Seldon packing cut in rings and smeared heavily with flake graphite and cylinder oil.

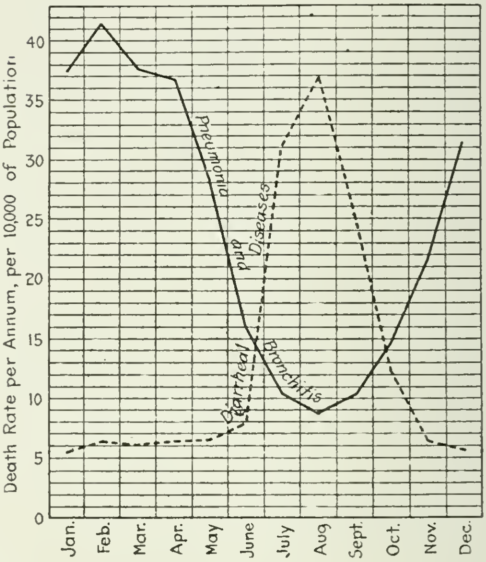
I would not attempt to run any machinery without a supply of flake graphite, and to prove how I value it, I have paid for it out of my own pocket for the past eleven years, as the railroad company by whom I am employed, does not furnish it.

A. H. Goff, Pumping Engineer.
Sanger, Tex.

CHEAP PRODUCTION OF OXYGEN FROM LIQUID AIR

The following data on the production and utilization of oxygen from the air we obtain from a lecture by Mr. George Claude before the *Societe des Ingeneurs Civils de France:*

A plant with a capacity of 50,000,000 cubic meters (1,765,000,000 cu. ft.) per annum occupies a space 20 x 30 meters (about 65 x 100 ft.). Only 15 attendants are needed. For small apparatus (capacity 1,750 cu. ft. of oxygen per hour) 1 HP.-hr. is required for one cubic meter (35.3 cu. ft.) of oxygen. For larger apparatus (capacity 7,000 cu. ft. per hr.), the production is 1.25 cubic meters (44 cu. ft.) per horsepower-hour. The production is expected to rise to 1.75 cubic meters (62 cu. ft.) per horsepower in the largest apparatus projected but not built—(capacity over 35,000 cu. ft. per hr.). The total cost of production (Societe de'l Air Liquide) has been guaranteed at 0.6 ct. per cubic meter of oxygen (35.3 cu. ft.), including depreciation. For this figure power is secured at 0.4 ct. per HP.-hr. (as the company uses blast-furnace gas and internal combusion engines).

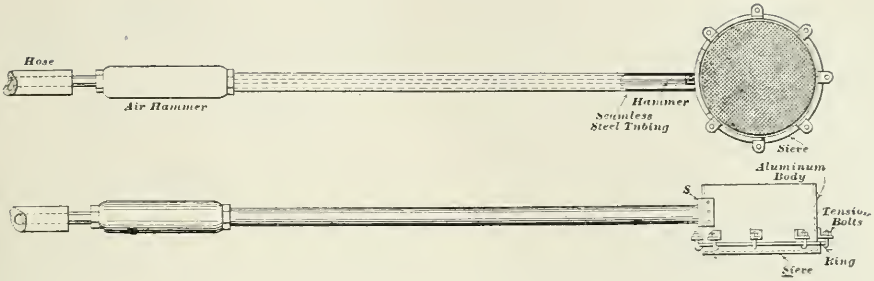


AIR AND FOOD CONDITIONS AND THE MORTALITY RECORD

This striking little diagram from the *Weekly Bulletin* of the Chicago Department of Health tells its own story most effectively. The notes which accompany the diagram so published are as follows:

Impure-air Diseases, Pneumonia and Bronchitis.—High in winter when people house themselves up and breathe the foul air of unventilated rooms. Low in summer when people keep their doors and windows open, when people live more in the open air.

Impure-Food Diseases, Diarrheal Diseases.—High in hot weather chiefly because of dirty milk for babies' food and contamination of foodstuffs by flies, dust, etc.



A PNEUMATIC DREDGE OR SIFTER

The cut herewith, adapted from *The Foundry,* shows a pneumatic dredge or sifter as used in enameled ware factories for distributing the enamelling powder over the heated castings. The body of the sieve is made of aluminum, to which angles are riveted with openings at their projecting ends. Brass wire cloth, 40 to 60 mesh, is placed over the bottom of the body, and a ring is drawn up over it, so as to hold it firmly in place. A wrought iron plate is fastened to the body at *S,* and to this is attached a section of seamless tube, at the other end of which is fastened a vibrator. This vibrator consists of a steel rod which contacts with a little rapidly reciprocating plunger transmitting the vibration to the plate, and this in turn vibrates the sifter. This plate should be of considerable thickness, as otherwise the constant hammering will soon distort it. These vibrators can be purchased from manufacturers of pneumatic tools. The air hose is attached at the end, as shown.

COMPRESSED AIR IN A SAW MILL

The Portland Lumber Company, Portland, Oregon, has installed an air compressor in the mill, and the superintendent, Mr. S. B. Stewart, writes to *The Timberman* about it as follows: "We are using compressed air on the edgers, bumpers, pickups, jump saws and trimmers. The operator operates his bumper just as well if it is fifty or sixty feet from him as if it is close to hand. All that is necessary to have between the bumper and the operator is a half inch pipe to convey the air from the valve to its location close to the cylinder of the bumper; besides, the air is rather quicker than a lever would be. We installed a 12x12 compressor, as we desired to use air to a more or less extent throughout the mill. We carry 30 pounds pressure on the trimmer, and expect to use about the same pressure on the bumpers and pickups. We use air for cleaning purposes in our planing mill as well as in the saw mill and carry it to the planing mill about 100 feet distant. When steam is conveyed a long distance it becomes sticky and wet, and for cleaning purposes tends to make the dust stick rather than remove it. With compressed air the removal is rapid.

"One of the most important advantages of the use of air over steam is that the lever required to operate the compressed air valves is very small, probably not more than 2 or 3 inches. The trimmerman operates the levers with one finger. Another advantage compressed air has over steam is the fact that in the manipulation of the lever there is no physical exertion necessary. Experience in handling men everywhere has shown that men who use their brains must be relieved as far as possible of physical exertion to get the best results. Another good feature of the use of air on the trimmer is that it increases its capacity on account of its rapidity of operation. I believe we can put at least 25 per cent. more lumber over our trimmer operated by air than by steam.

"In the installation of our trimmer the saws are counterbalanced, and as a result it only takes a mere fraction of air in order to operate the saw. One putting in compressed air to be used on the trimmer only would be required to put in only a small compressor, and the necessary outfit would cost less than the old steam rig.

"In substituting air for our trimmer we took out nearly a drayload of machinery. In its place we simply put in a half inch pipe from the manifold to the saw. Attached to each saw is a small cylinder made of 3-inch brass pipe with a cast base. The pipe from the manifold is tapped into the cast base. The top of the head is open the same as an ordinary well valve. They are very easily made and at a low cost. We do not require any stuffing box, merely a plain pump cylinder. We are also rigging up the trimmer to cut odd lengths by simply putting in another saw at the head of the trimmer one foot away from the first saw."

AUTOMATIC PURIFICATION OF NATURAL ICE

The following we take from a paper by Mr. Harold W. Cole, before the Natural Ice Association of America:

There are two stages in the purification of natural ice. The first is that brought about by the process of freezing itself; and the second the action which takes place in the ice after the ice is stored in ice houses. Ice is formed as a crystal on the surface of water, and the act of crystalization is invariably an act of purification. Numerous investigations, have shown that ice formed on water, part of which remains unfrozen, is from 90 per cent. to 99 1-10 per cent. purer than water was before the water was frozen. After the ice has eliminated both bacterial contents, solid contents and various chemical constituents by means of crystalization there remains a very small and practically negligible quantity of impurities in the ice. It would be entirely negligible if it were not for the fact that it may contain some bacteria, but if the ice was cut properly and stored in ice houses, as the majority of ice is before it is used, anywhere from one to two or three months, there is another process going on which results in its almost total purification. Bacteria are inured to a temperature about equal to that of the human body, 98 and a fraction degrees Fahrenheit; in addition to that the bacteria move about freely, and the majority of them require a certain amount of oxygen in order to live, and they require food in order to live. It will, therefore, be perfectly reasonable to suppose that if you take a number of bacteria and freeze them in a cake of ice so that they cannot move around, and therefore cannot seek out food and cannot get any air and are at a temperature of some 60 degrees or 70 degrees lower than that at which they were meant by their nature to live, they cannot live.

Numerous tests made by various scientists in several parts of the country have shown that of the small percentage of bacteria remaining in natural ice, when put in the house, less than 1 per cent. remain after storage of from six to eight weeks, and after a period of from twelve to twenty weeks no living bacteria are found bearing any disease. As a result of these investigations the State Commissioner of Health of the State of New York, in agreement with the Health Board of the State of Massachusetts, has publicly announced that there has never been a case of disease brought about by the use of natural ice, and that, as the New York State Commissioner says, ice cannot be from its nature and from the method of harvesting the bearer of disease.

FARTHEST NORTH POWER PLANT

Very near to North Cape, Norway, latitude 70, north, or at least one degree further north than Point Barrow the extreme reach of Alaska, is located a completely up-to-date steam power plant. This installation has followed the discovery of valuable deposits of iron, the ore being of such a character that shipment before treatment or concentration was impracticable.

The plant comprises, in the main room two 3750 brake horsepower De Laval multisage steam turbines, each direct connected to an 850 volt three-phase alternating current generator, developing a maximum of 2,625 kilowatts. On a lower floor are located one 360 brake horsepower De Laval steam turbine direct connected to a 240 kilowatt three-phase alternating current generator and one 180 brake horsepower direct connected to a 120 kilowatt generator. There are also two motor driven sets, these units being used for excitation purposes.

The boiler plant consists of five 500 horse power Babcock & Wilcox water-tube boilers with two economizers. The boilers are also equipped with superheaters and mechanical stokers. There are four high pressure De Laval Zeta pumps of 250 brake horse power each, and several small pumps used for various purposes. The condenser air pumps are located in the basement and are motor driven by means of noiseless chain belts. The buildings and entire equipment are perfect in their line and the plant as a whole is a fine example of the latest in steam and electrical engineering. The current generated is employed for the magnetic separation of the ore, about 600,000 tons to be shipped annually. The ore bed is said to have at least 400,000,000 tons available.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. JUNE, 1910. No. 6

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MECHANICAL INVENTION, DISCOVERY AND EXPLORATION

Mechanical or industrial inventions, such, for instance, as are usually the subject of letters patent, seem to be of two quite distinct types, so essentially unlike in fact that they may perhaps be better differentiated and distinguished by using different words in speaking of them. To the one, and the most numerous, class the word "invention" intelligibly applies, while those of the other class may be more correctly designated as discoveries.

In the one case the inventor sets out to accomplish some definite result, usually by mechanical agencies, and for this he selects combinations of operative devices, mostly familiar in detail, but which accomplish the new result desired. Of this class of true inventions are the typewriter and the sewing machine, and, in a larger way, the locomotive. They are each a wonder as a whole, but in ultimate detail the devices employed have generally been known and used long before. These inventions are always possible to persevering cutting and trying, to continuous selecting and rejecting, and usually many men co-operate, often unknowingly, to elaborate the final and completely successful apparatus.

The inventions of the other class, the discoveries or "happy thoughts," are recognizable by all as essentially different from these. They come to the few; they come in their entirety at once; they come unheralded; but they do come to those who are alertly and intelligently seeking such things rather than to those who are not so on the lookout. Sometimes the discovery is that of an important detail of a more or less familiar but constantly improvable machine, as, for instance, the piston inlet of the air compressor. Such a discovery as that bars all imitation; you either have it or you have it not, and, when priority of discovery is established, it completely protects itself against all infringement.

In the discovery class we must place also the Electric-Air Drill. It combines a single happy thought which is the central and dominating idea of the apparatus as a whole, and the discovery of it must have come all at once, although we may assume that it came to one who stood alert to see and quick to recognize it.

The discovery analogy extends beyond the first incident of perception, recognition and appropriation. After the discovery becomes an accomplished fact the thing discovered must still be investigated, and, as we might say, explored, that all its bearings and relations may be known and all its accompanying advantages made available, just as an island or a continent newly discovered must be explored and mapped. To the explorer surprises come, and it often happens that he finds the world more enriched by the new discovery than was at first realized. Analogous to this are the revelations which experience brings concerning the Electric Air Drill.

When the idea of it was first entertained it was evident at once that here was provided at least the possibility of dispensing with air compressor plants and long lines of piping in mining and other rock cutting operations. In the adoption of revolutionary improvements it is seldom that it is all clear gain. There are usually sacrifices or compromises to be made, and before the final adoption of the Electric Air Drill these were to be looked for. They have not been found. The drill in working is not in any respect inferior to the drill driven by constant air pressure. The drill itself is much simplified, the most troublesome and costly details both in construction and maintenance having been eliminated. The drill actually strikes a harder blow, because the air from one pulsator follows the piston with an increasing pressure while the other pulsator makes a decreasing pressure on the other side of the piston. The drill practically forgets its old habit of sticking in the holes, because the pulsators keep the air yanking at it, one side and then the other, so that if it does stick for a moment it is free again before anything can be done about it. The most surprising thing of all is that the Electric Air Drill requires much less than one-half the power, at the source of power, which the direct air operated drill requires to do the same work. The power economy of the drill is easily explained upon investigation, but it was practical experience instead of theorizing which first revealed it.

RAPID AND WONDERFUL AEROPLANE DEVELOPMENT

In all the history of mechanical achievement it would be difficult to find a parallel to the combination of intelligence and audacity with which a few men, in as few years, have lifted the art of flying from the dreamland of the impractical enthusiast into the world of brilliant accomplishment. It was not so very long since that a scientist of world-wide reputation attempted to prove that, because of certain fundamental principles, the art of flight by means of heavier-than-air machines was not commercially practicable. Nevertheless, within a period of considerably less than a year, more than one aviator has flown at a speed of over forty-seven miles an hour; another has covered a distance of 144 miles in a continuous flight of four and a quarter hours; a third has flown across the English Channel; and a fourth, Paulhan, the most distinguished aviator of them all, has soared nearly a mile into the air, and finally has surpassed even that feat by flying from London to Manchester, covering a distance of 186 miles, with but one stop for fuel, at an average speed of over forty miles an hour.

The significance of this really wonderful race between Paulhan, the Frenchman, and White, the Englishman, is apparent only when we consider some of the details which have been cabled to this side of the Atlantic. That Paulhan should have won the $50,000 prize in such superb style, at the very first trial, is a tribute both to his own skill in manipulation, and to the excellence of the Farman biplane with which the race was won; but to appreciate the full significance of the race, we must remember that both contestants, and particularly White, flew for a considerable stretch of the journey at night time, and, what is of even more importance, that they did not hesitate to make both the ascent and the descent in the darkness. No stronger evidence than this could be afforded that the aeroplane is an instrument of precision, which can be relied upon to answer with certainty to the controlling hand of the operator.

There is something strongly suggestive of bird-flight in the description of the manner in which one of the contestants, after leaving the ground, swept through the air in a wide circle in order to get the lay of the land and the proper direction of flight, or to pick up again a course from which he had been driven by the wind. But certainly the most difficult feat of all was that of making a landing at night time, in a locality with which the aviator was quite unacquainted, and where he had to make a wide detour, looking for a suitable stretch of unobstructed surface on which to alight.

Last year, in commenting upon the status of the art of flying, we pointed out that the one last obstacle to be overcome, before flight could be reckoned among the practical achievements, was that of successful starting and alighting upon the average surface which would be encountered in cross-country flying, and performing these feats with certainty in a breeze of ordinary strength. The London-to-Manchester race would certainly seem to prove that this important stage in the development of human flight has been reached and successfully passed.—*Scientific American.*

DINNER AND PRESENTATION TO DR. RAYMOND

One of the most notable events of its kind which the technical press has ever had the pleasure of recording, was the gathering at the Plaza Hotel, New York, on the evening of April 30th, of about 400 eminent scientists and personal friends of Dr. Rossiter W. Raymond in tribute and congratulation in commemoration of his 70th birthday and the completion of his 30th year of continuous service as secretary of the American Institute of Mining Engineers.

Of Dr. Raymond's range of accomplishments and the reach and completeness of his life record, our readers need not a word of reminder. It has only recently been aptly said of him: "It is an open question whether he plays chess better than he plays whist, or writes hymns better than he composes stories for children, whether he is stronger as superintendent of a Sunday school or as leader in the jiu-jitsu of a mining law suit, whether the preaches in Beecher's pulpit better than he lectures at Columbia, whether he talks more convincingly than he writes, and, finally, whether he is a great mining engineer or only a great man."

Among those who united in the tribute on this occasion were: Dr. James Douglas, E. G. Spilsbury and Jas. C. Boyles, past presidents of the organization of which Dr. Raymond also is a past president as well as its secretary; Dr. Lyman Abbott; George Westinghouse, president of the American Society of Mechanical Engineers; John A. Bensel, president of the American Society of Civil Engineers; Rawlinson Tennant Bayliss, vice-president of the British Institution of Mining and Metallurgy, who presented to Dr. Raymond the gold medal of that society; Sorzano de Sajada of the Societé des Ingénieurs Civils de France; John Fritz; Frank Dawson Adams, president of the Canadian Mining Institute; Geo. W. Maynard; Robert W. Hunt; Thomas Commerford Martin, past-president of the American Institute of Electrical Engineers, and William Lawrence Saunders, president of the Ingersell-Rand Company.

Dr. Douglas presented two handsomely illuminated parchments from the Iron and Steel Institute and the Vereinsdeutscher Eisenhüttenleute. After the reading of resolutions passed by the British Institution of Mining and Metallurgy and Société des Ingenieurs Civils de France by their respective representatives, and at the conclusion of Dr. Raymond's response, a large floral mound, built up to suggest a western mine with the buildings, smelters and workmen's homes, was parted and disclosed a silver service, which was presented to the guest of honor and his wife.

The unique function of this notable occasion was the presentation by Mr. Saunders of forty-seven American Beauty roses to Mrs. Raymond in commemoration of forty-seven years of married life. Mr. Saunders address was as follows:

All honor to our guest, but it falls to my lot to speak of one who is preferred before him; of one who at this feast is as welcome as the flowers in May.

Lord Burleigh in giving advice to his son, said, "Use great prudence and circumspection in choosing thy wife, for from thence will spring all thy future good or evil."

Forty-seven years ago was a critical period in the life of our guest: Young, able, ambitious and yet strong in faith and love, he knew that the glory of young men should be their strength, and so towering in the confidence of twenty-three he plucked from highest boughs this "flower of wifely patience."

If the gospel be true, that "a prudent wife is from the Lord," then

"There's in you all that we believe of Heaven,
Amazing brightness, purity and truth,
Eternal joy and everlasting love."

Look back, sir, through the pleasures of memory on the events of nearly half a century of your active life; think of your greatest joys; recall the applause of the multitude, the honors bestowed, the pomp of power, the satisfaction gained by prosperity, happiness and through troops of friends, yes, even up to this night which should be a proud moment to any man, yet you will not deny that after all "there's nothing half so sweet in life as love's young dream."

There is a beautiful song called "Let me dream again," in which are the words: "O, do not wake me, let me dream again." To you love's dream has had no awakening since that bright morning when you sailed forth upon the sea of life, with this "gentle, trusting, loving wife."

The story is told of a man who led in everything. He was the captain of the ball team; the leader in his class; the county chairman and the deacon in the church. In due course he took to himself a wife, and a friend who knew him well was asked how he was getting along since he married. He always led everyone and it was said that no woman could ever get ahead of him. "Oh," said the mutual friend, "he is still leading, I suppose, but his wife is just behind holding the reins."

We drink to her who is *his* wife and long may she reign!

Here's health to her,
Here's wealth to her,

to her who is his guide, philosopher and friend; to her who is more than a star, for she is a constellation of virtues, she is the comet and he, why he is only the man in the moon! To her, to her!

On behalf of his friends and yours it is my privilege to lay these flowers at your feet.

Here is a rose for you for every year of wedded life: It lifts its face above the thorns as you have always done, as you do now.

"Here, mark you, where the bolt of Cupid fell:
It fell upon a fragrant little flower,
Before, milk-white, now crimson with love's
wound."

Compressed air in the foundry serves many uses: operates molding machines, air hoists, either independent or in combination with jib cranes, sand sifters, rammers, chipping hammers and sand blast for cleaning castings, pushes core oven cars into and out of the ovens, promotes combustion in melting furnaces.

The water temperature at the Ward shaft on the Comstock lode is 160 deg. Fahrenheit.

CONTINUOUS FILTRATION OF BATH WATER

At the Rotherhithe baths, in London, the water, which normally would require frequent renewal, is used over and over, a system of continuous filtration and purification being employed which possesses demonstrated economical and hygienic advantages. There is a cast iron tank of filter gravel, which is cleansed every few days by blowing water and live steam through it, and an aerator on the roof consisting of perforated zinc trays. Dirty water from the swimming tanks is raised to the aerating tower where it receives a fresh supply of oxygen and then passes down through the filter. The filter effluent passes through a heater, which uses the exhaust steam from the pumps and raises its temperature to 74 deg. Fahr. The plant circulated 20,000 gallons per hour, changing the entire contents of the swimming tank every 4½ hours by this continuous circulation. The body of water used is actually renewed only twice during the summer and once in the winter.

CLEANING SHOULD BEGIN AT HOME

A dozen launderers are looking into the advisability of investing in a vacuum cleaning outfit for the purpose of cleaning for other people and for pay, while there are a hundred dozen launderers whose plants are looking as though they ought to employ someone to come in with a vacuum cleaner and take some of the dust out. They will go through the nonsensical operation of stirring this dust up every day so that the finest of it can get a short vacation from the floor, to spend on the various garments lying or hanging about, and on other surfaces, calling this operation cleaning, when it is simply transferring the dust from the floor (where it would do less harm, really) to where it certainly should not go. And all of this when the dust could, at slight expense, be taken entirely out of the premises. Wonder why?—*National Laundry Journal.*

NOTES

The Chicago office headquarters of the Ingersoll-Rand Company is now in Suite 1503-1505-1507 People's Gas Building, 150 Michigan avenue.

We have received the first issue, May, 1910, of *Foundry News*, published by the Foundry

News Company, 50 Church street, New York. It is an attractive and every way excellent number and shows the editor to be fully in touch with the up-to-date foundry.

The general offices of the Sullivan Machinery Company have been moved from the Railway Exchange Building, Chicago, to Suite 413, People's Gas Building, 150 Michigan avenue.

The Aëro Club of America has secured quarters in the Engineering Societies building, 29 West 39th street, New York City, which now forms the home of twenty-five engineering and scientific bodies with some 30,000 members.

When Halley's comet was nearest the earth the two bodies, going in opposite directions, passed at a speed relative to each other of about 2,500 miles per minute.

Fort Worth, Texas, is now supplied with natural gas from the Henrietta fields, 95 miles away. The quality of the gas is excellent, the wells are large and the pressure is enough to send it several times the distance.

A company is being formed in Winnipeg with the object of establishing a plant for the supply of steam, hot water, and compressed air by means of underground conduits, and an application has been made for the necessary powers. The boiler plant will probably be erected on the Red River close to the busy portions of the city, and will be of 5,000 horsepower.

On the property of a single marble company in North Georgia are deposits of marble which as far as they have been prospected, are capable of yielding 1,000,000 cubic feet of the material a year for 4,000 years. No idea of the depth of the deposit is had, and one of the quarries has already gone down nearly 200 feet without there being any indication that the bottom of the deposit is being approached.

The method of boxing the compass by reading the numbers of the degrees all around from north, starting to the right, is being seriously considered with a probability of adoption by the United States Navy. East would, of course, be 90 degrees; south, 180; west, 240; and north, 360; and all intermediate points as thus indicated. There would be no more west-sou-west, no'th-east-by-no'th or the other picturesque nauticalisms.

The United States lighthouse officials for the Pacific Coast have decided to construct no more lighthouses, but to establish acetylene gas beacons similar to those which have been used for some time in Canadian waters along the coast.

The various states in Australia have for some time had laws on their statute books requiring mine managers to provide water sprays where necessary to allay the dust from drills or other sources in order to prevent miner's phthisis. These regulations have not been strictly enforced of late, with the result that the spread of the disease has been alarming, and steps are now being taken to insure the proper observance of the law in all cases.

A series of experiments was recently made at Johns Hopkins University to determine the dielectric strength of air. It was found that the point at which a brush discharge occurred is only slightly affected by the moisture in the air. From dry air to saturated air there is a drop in voltage of the discharge of less than 2 per cent. An increase of temperature from the freezing point to 40 deg. Cent. caused the lowering of voltage by about 3 per cent.

A coal dust burner using a jet of compressed air instead of a fan blast has been in successful operation for the past two years in a southern cement factory. Air at high pressure passes through a Koerting ejector nozzle and enters the kiln through a horizontal pipe. A vertical fuel supply pipe opens into the horizontal pipe just beyond the discharge end of the nozzle and between the nozzle and the kiln, the rapidly moving air jet carrying the coal dust into the furnace.

Aerial appartus seem to be rapidly attaining commercial status. An English motor supply company with an aviation department publishes a catalog of aeroplanes with full descriptions and prices. The Bleriot monoplane can be had for about $2,500, and a Farman biplane for from $4,200 to $5,500, the price varying considerably according to the engines provided. The Santos-Dumont monoplane may be bought for a mere $1,500, while the Wright machine commands a price of from $5,500 to $6,000.

The three engineers appointed by the Canadian government to consider the application of the St. Lawrence Power Company for permission to dam the Long Sault Rapids at Cornwall, Ontario, report that the enterprise is worthy of most serious consideration. They urge that, before the government approval is given, there should be a complete agreement between Canada and the United States as to the supervision and control of plants on both the Canadian and New York State banks of the river.

Although amounting by weight to only about 0.034 per cent. as against 21 of oxygen, the carbonic acid in the atmosphere shows surprisingly powerful chemical properties. Under conditions controlled by the chemist, carbonic acid may be regarded as the weakest of inorganic acids, but when dissolved in surface or other waters, and particularly when absorbed merely by moisture where it has the maximum surface action, it possesses the power of gradually decomposing most of the rock-forming silicates.

What is claimed as the largest and most powerful windmill in England has just been completed at Willesden, where its capacity is being tried under varying conditions. It is intended for a farm near Bristol, its use there being to generate electricity, supply power to run crushing machinery and work the pumps. From the trials made it is said this new wind machine is capable of generating sufficient electricity for 300 lights, to crush oats and grind maize, work an electric lift, cook the food, and heat a room at a cost of ½d. per unit.

Among the foundation industries of the United States mining ranks second only to agriculture. It now contributes over $2,000,000,000 annually to the national wealth, as compared with $7,500,000,000 from agriculture; but it contributes 65 per cent. of the freight traffic of the country, as compared to 8½ per cent. from agriculture. Its manufactured products in 1907 amounted to a total of $4,318,598,661, and the wages paid to the men engaged in such manufacture amounted to $863,558,487, as against $735,101,760 paid to those engaged in agriculture.

Passenger subways under busy street intersections, to enable pedestrians to cross the street safely are being constructed in London at the so-called "Elephant and Castle." These street subways consist of tube tunnels 8 ft. inside diameter. Stairways lead down to these tubes, and an underground room 20x23 ft. at the junction of the tubes enables passengers to cross in different directions without crowding.

Calcareous nitrogen containing 20 per cent. nitrogen costs for its production from $47.27 to $55.15 per short ton. This makes the actual nitrogen in the compound cost 11.8 to 13.6 cents per pound, while the cost of nitrogen in compounds formed by the direct combination of the elements in the air is generally conceded to be less. The experiments made with fertilizers of either system, in comparison with Chilean saltpeter, are generally favorable to the artificial product. In sandy soil the calcium nitrate formed by the direct combination of the elements in the air brought even better results than the Chilian saltpeter.

The United States Geological Survey has completed a line of spirit levels through Death Valley, California, and, much to the surprise of every one famliar with the region, has ascertained that the depth of that area is not so great as was supposed. Preliminary figures give for the lowest point a depth of 276 feet below sea level. The Geological Survey now has elevation marks on the highest and lowest points of dry land in the United States. It is a strange coincidence that these two extremes are both in southern California and only 75 miles apart. Mount Whitney is a foot or two over 14,500 feet above sea level, while Death Valley, as above stated, is 276 feet below.

A committee of engineers appointed by the Roads Improvement Association of England to examine various sections of road which had been sprinkled with calcium chloride solution to lay dust has just rendered a report. The committee says that the treatment has the ill effect of causing, during the winter months, an abnormal quantity of sticky mud, a decided tendency to licking up, and a disintegrating action upon the macadam surface. Nevertheless the committee concludes that the calcium chloride solution is probably not more injurious to the macadam roads than the excessive water now demanded by the public in order to keep the dust down.

The total rainfall of the United States, including snow and that on water areas, has been given by Dr. M. J. McGee, secretary of the Inland Waterways Commission, as 215,000,000,000,000 cubic feet a year. Half or more is evaporated. About one-third flows into the sea. The remaining one-sixth is either consumed or absorbed. Of the 70,000,000,000,000 cubic feet flowing annually into the sea less than 5 per cent. is used for power. It is estimated that from 85 to 95 per cent. of the volume is wasted in freshets or destructive floods. The theoretical power of the streams is over 230,000,000 horsepower. The amount now in use is 525,000 horsepower. The amount available, at a cost comparable to that of steam installation is estimated at 37,000,000 horsepower.

In the 31-day period from the morning of March 3 to the morning of April 3, No. 1 shaft on the Moodna Siphon of the New York City Catskill Aqueduct, near Cornwall, was deepened 177 ft. The shaft was about 365 ft. deep on March 3. This is claimed by the contractors as a new record for American shaft sinking. The shaft is circular, with a minimum allowable radius of 7 ft. 11 ins. and an average diameter of about 16 ft. 8 ins. The shaft was sunk with one eight-hour drilling shift and two-eight-hour mucking shifts daily. Thus 19 shifts were worked per week, two being lost on Sundays. The rock penetrated was hard Hudson River shale. Mr. Walter Steenburgh was in charge of the work described, under the general supervision of Mr. Francis Donaldson, Chief Engineer for the contractor, the Dravo Contracting Co.

The ordinary form of liquid bath for the determination of melting points has been modified by the introduction of an air-bubble system, causing a rapid circulation of the liquid, and hence a uniform temperature. The same idea has been very ingeniously applied by Mr. H. Stoltzenberg—*Zeitschrift für physikalische Chemie,* March 11th—in designing a low-temperature coling bath. The liquid—pentane—is caused to circulate by means of hydrogen bubbles through a spiral dipped in liquid air, ether and solid carbon dioxide or a mixture of ice and salt, according to the temperature required, and then passes into the vacuum-jacketed vessel in which the measurements are carried out. The temperature can be easily regulated by altering the amount of the spiral immersed, and can be kept very constant.

The use of compressed air for raising sunken ships is no longer a novelty in any part of the world, a recent instance being that of the steel steamer Fleswick, in Cork harbor, Ireland. The wrecked vessel, which was 180 ft. long by 28-ft. beam, rested on her side in 27 ft. of water forward and 39 ft. aft, on a muddy bottom. The coal which formed her cargo was first taken out with a grab bucket and plate scraper, and then the hull was made as nearly as possible air tight by closing the hatches with steel plates placed by divers. Air was pumped in, but owing to the dip of the ship's stern, more of the air went forward than aft so that a hulk had to be used to assist in lifting the stern off bottom. The ship was floated and uprighted with the assistance of a barge near shore. She was then docked, and after some temporary repairs was taken to Liverpool.

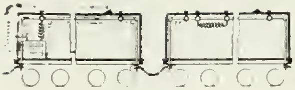
White gunpowder is seldom heard of because is does not lend itself to general use. It consists of a mixture of two parts chlorate of potash, one of loaf sugar and one of prussiate of potash. These are reduced to a powder and then mixed while dry. Its explosive power is very great but it is not safe, exploding on slight jar.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

APRIL 5.

953,795. AIR-VALVE FOR PNEUMATIC CONTROL SYSTEMS. LAWRENCE S. NASH, Detroit, Mich.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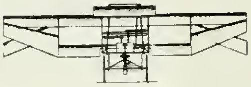
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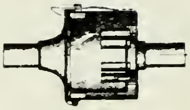
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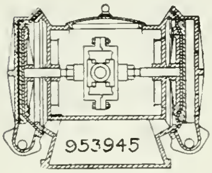
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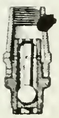
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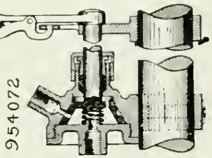
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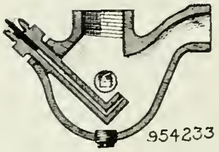
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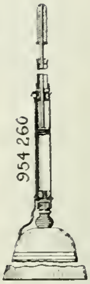
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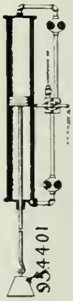

954401

Pneumatic Patents, April 5.

953,810. FLYING-MACHINE. Edward J. Augsberger, Philadelphia, Pa.

953,945. VACUUM MEMBRANE-PUMP. Martin Falk, Cologne, Germany.

954,072. FLUID-PRESSURE REGULATOR. Adolph G. Beckman, Baltimore, Md.

954,164. ATTACHMENT FOR VACUUM-SWEEPERS. John Broekema, Rogers Park, Ill.

954,231. CAR-DOOR BURGLAR-ALARM. George A. Ulrich, Guadalajara, Mexico.

954,233. SAND-DISTRIBUTER FOR LOCOMOTIVES. Harry R. Wasem, Fort Dodge, Iowa.

954,260. DUST-BLOWING ATTACHMENT FOR BROOMS, BRUSHES, AND THE LIKE. Frank C. Davis, Tucson, Ariz.

954,268. PLANT FOR THE HANDLING AND UTILIZATION OF LIQUID AIR AND THE LIKE. Horace Dumars, Glen Ridge, N. J.

954,401. FLUID-ACTUATED BALANCED HOIST. George F. Steedman, St. Louis, Mo.

2. A fluid-actuated balanced hoist, provided with a piston that is adapted to move a load, means, for creating a uniform pressure on both sides of the piston to cause it to move in one direction, means for reducing the pressure on one side of the piston to cause it to raise said load, and means for cutting off the supply of fluid to both sides of the piston to hold the piston at rest between its two limits of movement.

APRIL 12.

954,451. DESICCATING APPARATUS. Irving S. Merrell, Syracuse, N. Y.

954,550. LIQUID-GAGE FOR PRESURE-TANKS. Arnold Verhoeven, Marianna, Ark.

954,560. DUMPING-CAR. Carl P. Astrom, Hasbrouck Heights, N. J.

4. The combination with a dumping car-body mounted to tilt on trunnions of a cylinder and piston connected to actuate said car-body, a stationary checking piston within the actuating piston, and means for regulating the passage of fluid between the sides of said checking piston to control the speed.

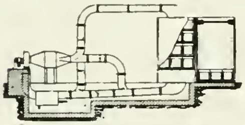
954,574. MEANS FOR STEERING FLYING-MACHINES. Albert Koegler, San Francisco, Cal., and Kamillo Stelzer, Jr., Dresden, Germany.

954,605. FLUID-COMPRESSOR. Warren W. Annable and John W. FitzGerald, Grand Rapids, Mich.

954,706. ROCK-DRILL. Grant W. Smith, Chattanooga, Tenn.

954,726. VACUUM CLEANING APPARATUS. Henry E. Fanshawe, New York, N. Y.

954,733. FLYING-MACHINE, ETC. Anna O. Hagstedt, New York, N. Y.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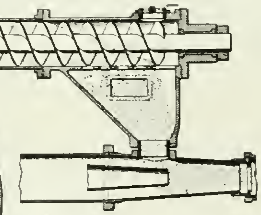
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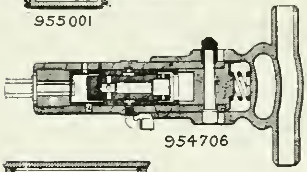
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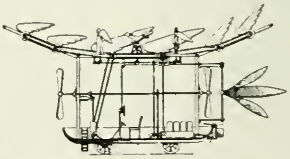
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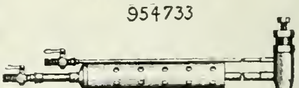
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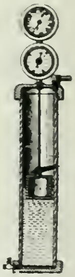
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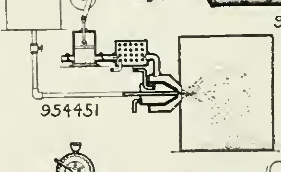
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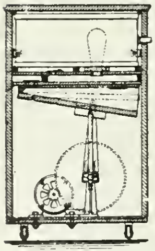
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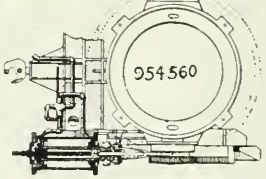
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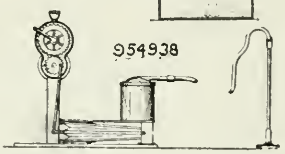
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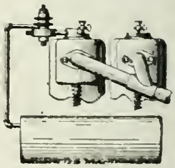
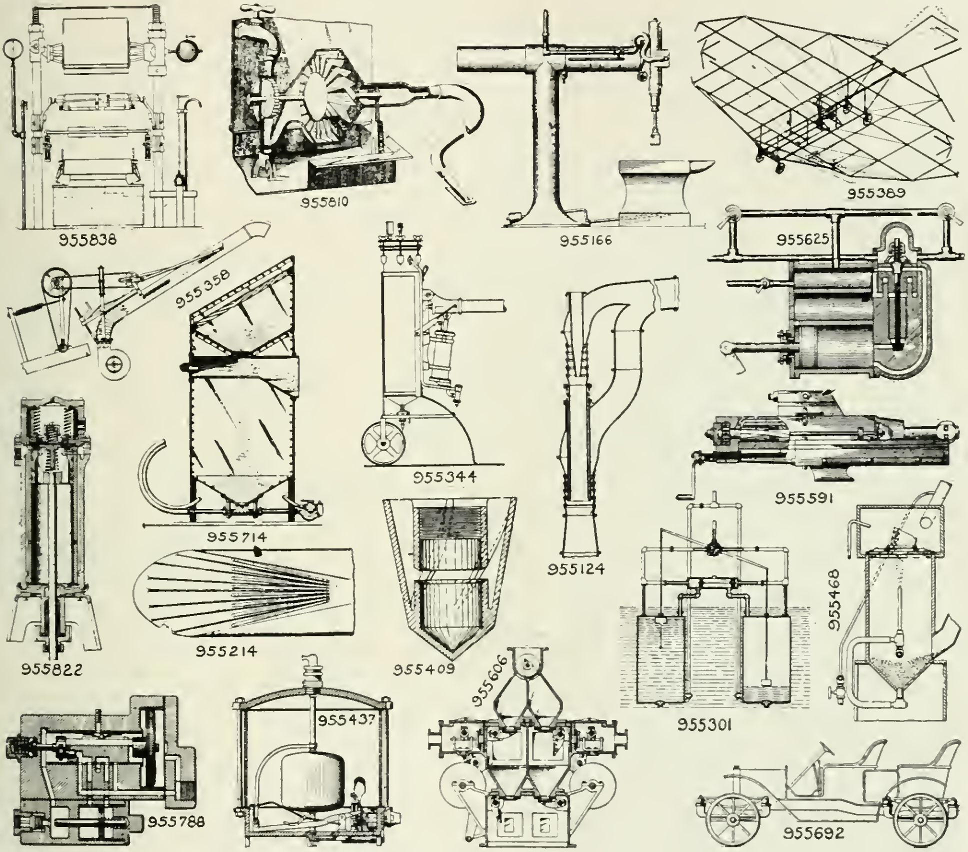

954605

Pneumatic Patents, April 12.

954,938. PNEUMATIC DUST-COLLECTOR. Fred C. De Vallant, Earlville, N. Y.
954,944. MECHANISM FOR FEEDING PULVERIZED COAL. William R. Dunn, Easton, Pa.
955,001. APPARATUS FOR MOISTENING YARNS. Paul Schilde, Hersfeld, Germany.
955,049. AIR-SHIP. Gustave H. Brekke, Seattle, Wash.
955,064. BLOWPIPE FOR WELDING METAL. Patrick J. Griffin, Camden, N. J.
955,118. VACUUM CLEANING APPARATUS. Henry E. Fanshawe, New York, N. Y.
955,296. COMPRESSED-AIR MOTOR FOR PUMPS. David R. Tripplehorn, Findlay, O.
955,301. WATER-ELEVATOR. James L. Wray, Kewanee, Ill.
955,305. WIND-MOTOR. Albert W. Bailey, Stewardson, Ill.
955,321. AIR-PUMP. David F. Cornell, Rochester, Minn.
955,344. PAINTING-MACHINE. Hans Mikorey, Schoneberg, near Berlin, Germany.
955,358. PNEUMATIC STRAW STACKER AND ELEVATOR. August Rosenthal, West Allis, Wis.



Pneumatic Patents, Aaril 19.

APRIL 19.

955,124. HYDRAULIC AIR-COMPRESSOR. Peter Bernstein, Mulheim-on-the-Rhine, Germany.
955,166. PNEUMATIC-HAMMER SUPPORT. Henry M. Jacobs, Eureka, Utah.
955,214. PROPULSION OF VESSELS. Frederick W. Schroeder, London, England.

1. Apparatus for propelling deep draft vessels consisting of a vessel having a series of grooves extending aft on the inclination of the stern, a longitudinally arranged tube in each groove, said tubes having openings therein directed oppositely to the direction of propulsion, said grooves comprising air chambers increasing in cross sectional area as they extend aft, and means for propelling the vessel by forcing air or gas through said tubes, substantially as described.

955,363. AIR SANDING DEVICE. James E. Scobee, Salt Lake City, Utah.
955,389. AEROPLANE. Lagar R. Culver, Salt Lake City, Utah.
955,409. AIR-DISTRIBUTING NOZZLE FOR AIR-LIFTS. George L. Joss, Monmouth, Ill.
955,437. AUTOMATIC AIR-COMPRESSOR. John Rogers, Bridgeport, Conn.
955,468. SAND-BLAST MACHINE. Charles F. Motz, Moon township, Beaver county, Pa.
955,591. ROCK-DRILL. James S. Harlow, Mineral, Va.
955,606. APPARATUS FOR FEEDING OR DISCHARGING GRAIN, ETC. Eugene Moreau, New York, N. Y.

3. In an apparatus for feeding or discharging material to or from a vacuum tank, the combination of a receiving chamber having an exhaust passage, an inlet valve which controls the inlet

of said chamber, and an outlet valve which controls the outlet of said chamber, one of which valves is exposed to the atmosphere while the other valve is exposed to the vacuum, an exhaust valve which controls said exhaust passage, and mechanism for opening and closing each of said valves periodically, and operating to open said exhaust passage when said inlet and outlet valves are closed, substantially as set forth.

955,625. AIR-BRAKE SYSTEM. Andrew J. Wisner, Philadelphia, Pa.

955,686. PNEUMATIC HAMMER. Edmond W. Raikes, Cleveland, Ohio.

955,692. PNEUMATIC SPRING SUSPENSION FOR VEHICLES. George A. Rhoads, Uhrichsville, Ohio.

955,714. SAND-BLAST APPARATUS. George F. Steedman, St. Louis, Mo.

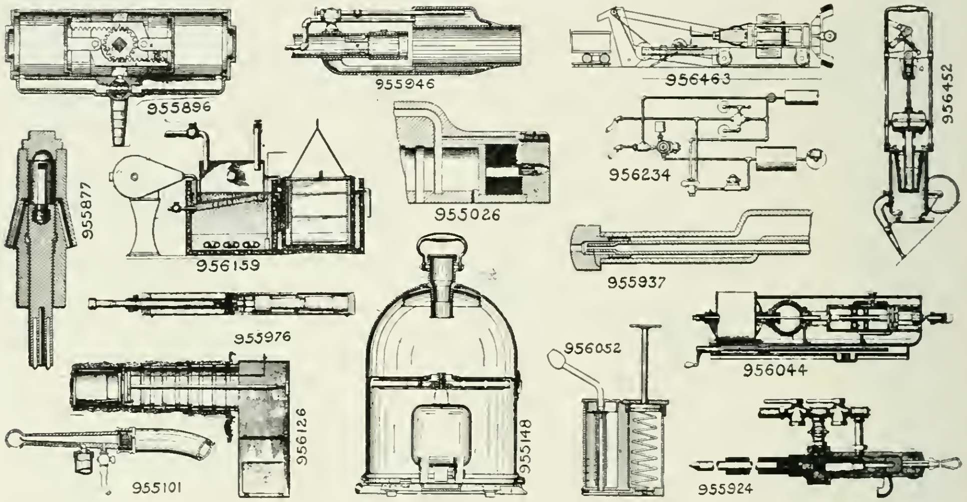
955,788. AIR-BRAKE. Charles W. Frye, Atlanta, Ga.

955,810. VACUUM CLEANING APPARATUS. Albert F. Krause, Buffalo, N. Y.

955,818. OZONIZER. Anthony Lohman, Philadelphia, Pa.

955,822. COMPRESSOR. John D. Mayhew, Tyler, Tex.

955,838. MOLDING-MACHINE. John Allenson, St. Paul, Minn.



Pneumatic Patents, April 26.

APRIL 26.

955,877. PNEUMATIC TOOL. Franklin M. Iler, Denver, Colo.

955,886. PNEUMATIC CLEANER. Elmyr A. Laughlin, Chicago, Ill.

955,896. FLUID-MOTOR. William J. Morrison, Pittsburg, Pa.

955,924. PNEUMATIC DRILL. Samuel A. Titus, Cananea, Mexico.

955,938. ATOMIZER. John R. Ballentine, Toledo, Ohio.

955,946. OIL BRAZING-BURNER. Richard D. Conrad, Pittsburg, Pa.

1. In an oil brazing burner, a vaporizer having a bore therethrough, an air-blast tube in alinement with said bore, an oil-supply pipe leading to said vaporizer, a conduit connecting the vaporizer with the air-blast tube, and a mixer in said tube in advance of the point of discharge of the volatilized fuel thereinto, the discharge end of the tube and the inlet end of the bore being relatively positioned to effect combustion within the bore.

955,976. AUTOMATIC PERCUSSIVE APPARATUS. Wilhelm Mauss, Johannesburg, Transvaal.

3. In combination, a fluid actuated percussive engine including a reciprocating percussive member and in which the quantity of fluid admitted to the front cylinder space varies with the extent of the forward stroke of the percussive member, means adapted automatically to effect controlled forward movement of the engine, said last named means being governed by the percussive member and operating to produce forward movement of the engine upon the rearward stroke of the percussive member exceeding a prescribed limit.

956,026. SPRAYING DEVICE FOR ROCK-DRILLS. William J. Barnett, Germiston, Transvaal.

956,044. ROCK-DRILL. Henry A. Dalmas, Manassas, Va.

956,052. POCKET-ATOMIZER. Frank C. Dorment, Detroit, Mich.

956,100. VACUUM-CLEANER. Robert B. Hutchinson, Wilkinsburg, Pa.

956,101. SPRAYING APPARATUS. William B. Inglis, Pawtucket, R. I.

956,103. HUMIDIFIER. James Kelly, Providence, R. I.

3. In a humidifier, the combination of a water pipe adapted to discharge water under pressure; an air pipe adapted to discharge air under pressure; a valve in the steam pipe having a gear; a valve in the air pipe having a gear in mesh with the first named gear; a distributer adapted to receive said water and air and the same to discharge under pressure: and means for receiving said water and air from the pipes and to mingle and deliver the same to the distributer.

956,126. CAISSON CONSTRUCTION. Ogden Merrill, New York, N. Y.

956,148. VACUUM-CLEANER. George S. Bennett, San Francisco, Cal.

956,153. AIR-BRAKE OR TRAIN-PIPE VALVE. Albert Oleson, Toledo, Ohio.

956,159. AIR PURIFYING AND DISTRIBUTING APPARATUS. William B. Patrick, Woodland, Cal.

956,234. COMBINED AUTOMATIC AND STRAIGHT AIR-BRAKE. Walter V. Turner, Edgewood, Pa.

956,287. CUT-OFF FOR FLUID-PRESSURE MOTORS. Joseph H. Champ, Cleveland, Ohio.

956,452. HAND VACUUM-CLEANER. John S. Thurman, St. Louis, Mo.

956,463. TUNNELING-MACHINE. William F. Wittich, Erie, Pa.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV JULY, 1910 No. 7

A NOVEL AND INGENIOUS AIR HAMMER

It is now coming to be quite generally realized that for practically all classes and sizes of steam hammers compressed air is much to be preferred for the operating fluid. The improving and perfecting of the large air hammer, however, is given more attention in Great Britain than in the United States, so that we have frequently to notice new and ingenious developments in this line originating on the other side of the water. The illustrations which we here reproduce from *The Engineer,* London, show a new type of air operated hammer built by B. and S. Massey, Openshaw, near Manchester, England.

The points to be borne in mind by the designer of a steam hammer at the present day are concisely stated as follows: The clearance and back pressure losses must be reduced to a minimum; the air must be used expansively; the flow of air into the working cylinder after the blow has been struck must be prevented; and the working pressure of the air must receive due consideration. The reduction of clearance on the top side of the piston, at any rate, is not difficult of attainment, but on the lower end of the cylinder the hammer builder has to take into consideration the differing thicknesses of the work to be dealt with and the possibility of the sinking of the anvil block. On account of these factors a hammer in which air is alternately admitted to and exhausted from the lower side of the piston is liable to heavy clearance losses. Moreover, as the hammer falls with great velocity, which increases as the piston descends, back pressure is difficult to avoid in this type of hammer unless the ports are made of ample area when the clearance losses are increased.

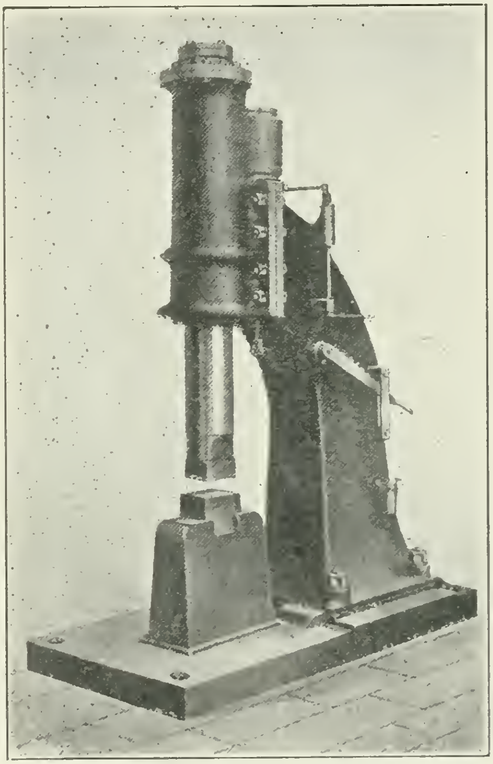


FIG. 1. MASSEY AIR HAMMER.

In the hammer here shown the space below the piston is always open to the pressure of the air from the compressor, this tending constantly to lift the hammer, whereas the air at the same pressure is alternately admitted to and exhausted from the top side of the piston. In this manner it will be seen that the only passage which has to be periodically filled and emptied, is a short one between the valve and the top of the cylinder, and the bottom port may be as large as reasonably possible without entailing any waste of air. It becomes, in fact, a part of the air storage system. When the hammer is forced down, owing to the difference between the areas above and below the piston, the lifting pressure is overcome, and the energy is expended chiefly in striking the blow, but also in compressing the volume of air below the piston for the subsequent raising of the hammer. The amount of air required, however, is less than that required for a separate admission for each up and down-stroke, owing to the abolition of the clearance loss and the absence of back pressure.

Another feature of this new hammer is that the air is used expansively on all blows. A fixed cut-off takes place at about half-stroke, and as an expansion from one to two with air pressure at 45 lb. per square inch is calculated to give 90 per cent. of the maximum work in the air, a substantial gain is effected. For light blows an even greater degree of expansion is obtained by the hand movement of the valve, enabling the cut-off to be made before half-stroke. A further point in the design of this new hammer which adds to its efficiency, is the prevention of what may be termed "after-flow" of the air, into the top side of the cylinder after the blow has been struck. It is obvious that such a condition must be as wasteful of power as it is useless. The after-flow in some hammers is induced by the piston travelling so fast in the later stages of the stroke, that the air cannot enter the cylinder quickly enough to maintain the neseccary supply. The result of this is, that when the blow is struck, there may be only a low pressure on top of the piston, while after the blow air continues to flow in until the supply pressure has been reached. The arrangement for working expansively is claimed to prevent this.

A general view of the new Massey hammer is given in Fig. 1, while Fig. 2 shows very clearly the construction and arrangement of the cylinder and ports, and the cycle of operations. Referring to the three views in Fig. 2, it will be seen that the lower end of the cylinder is always in free communication with the air supply through a large port A, the constant pressure serving to keep the hammer normally in the raised position at the top of the stroke as in the lefthand view in Fig. 2. The air inside the ram below the central guide is used as a spring or cushion, being compressed on the up-stroke and expanded on the down-stroke. The combined effect of the two pressures—the constant one below the piston and the varying pressure within the ram—gives a resultant upward force which decreases as the ram approaches the top, a rapid and lively action being thus produced. When the piston valve is raised, as in the centre view in Fig. 2, the top of the cylinder is closed to the exhaust and put into communication with the bottom of the cylinder through the port B, and thus with the air supply. The compressed air, therefore, passes from the supply on to the top side of the piston and forces the ram down. As the ram descends the piston passes the port B, and in so doing cuts off the supply of air to the top of the cylinder. During the remainder of the stroke, therefore, the air already admitted is used expansively, and this expansion takes place no matter what kind of blow is struck, no further air being admitted. In order to permit of the striking of light blows with short strokes, a small port can be opened by the attendant's lever, admitting just enough air to allow the piston to fall. This port is closed again when the valve is moved further for a long stroke; while for "holding-down" purposes the second lever shown in Fig. 1 enables air at full pressure to flow into the cylinder, even when the piston is at the bottom of the stroke. To avoid confusion in studying the sectional views in Fig. 2, it should be stated that the piston valve has nothing whatever to do with the supply of air to the bottom of the cylinder, although it controls the flow between the ports B and C, and when rotated by the upper handle shown in Fig. 1 allows the full pressure to flow into the cylinder for the purpose previously mentioned.

Fig. 3 represents a typical pressure diagram for heavy blows taken at the full speed, 100 blows per minute. The sharp cut-off alluded to and the sustained expansion line and light back pressure are are all well shown. Fig. 4 is a diagram for light blows at a quick speed. In this case only a partial admission of air takes place, and the air being cut off early by the valve F begins to expand almost at the commencement of the stroke. This card also shows the diagram of the pressure below the piston, which remains the same for all blows. The small mushroom valve G, shown in the sectional views is intended for admitting the

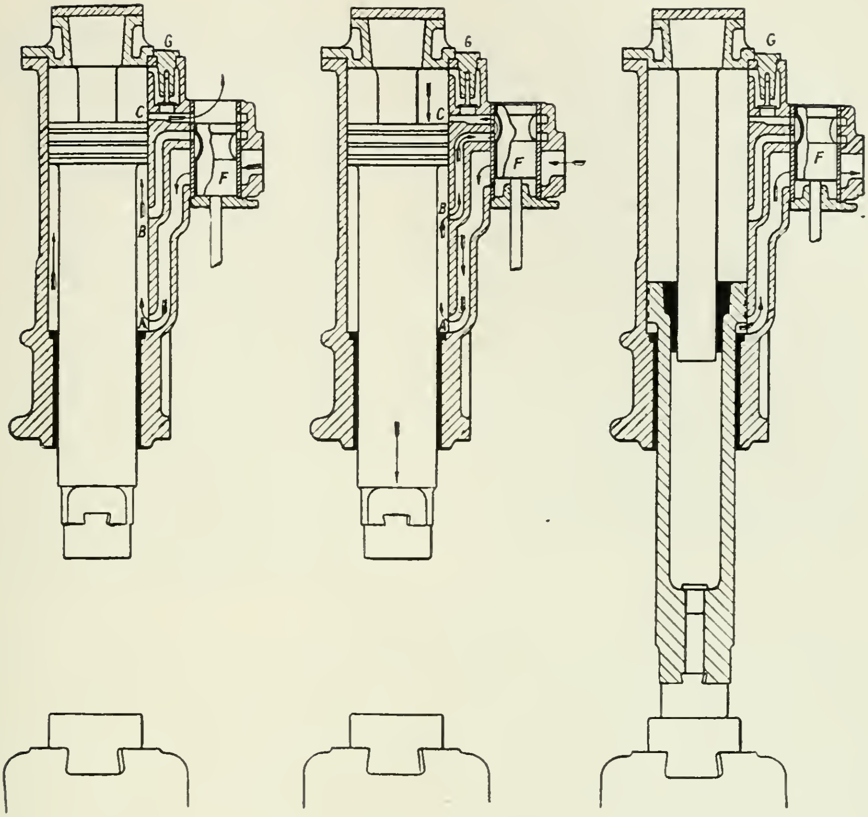


FIG. 2. MASSEY AIR HAMMER.

air pressure into the space on top of the piston in case the latter has risen above the port C. The hammer is specially adapted for smithy and forge purposes. The ram is circular in section, and works through a long phosphor bronze sleeve at the lower end of the cylinder. It is bored out centrally to receive an internal guide which is rigidly attached to the cylinder cover. The guide works through a phosphor bronze bush in the head of the ram, and is shaped so as to prevent turning. Being entirely enclosed, a perfectly air-tight fit is not necessary. The hand-operated valve gear resembles very closely that of a hand-controlled steam hammer, a separate movement being required for each blow. There is, however, no need for a "tripper," owing to the force on the upward stroke bereduced automatically as the ram rises.

The hammer is made in six sizes, namely, 3, 5, 7, 10, 15, and 20 cwt. The 5-cwt. hammer, which we have seen in successful operation, has a ram 9½ in. diameter, maximum

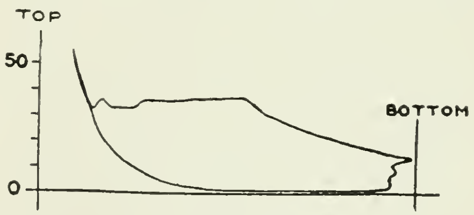


Fig. 3

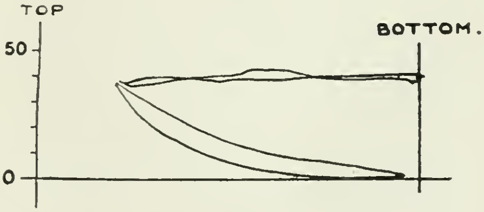


Fig. 4

stroke 24 in., and weighs complete about 5½ cwt. The overhang to the pallett centres is 24 in., and the total height from the floor 9 ft. It was operated by air at 45 lb. pressure. The following are the particulars of the average and maximum power consumptions, etc.:—

Maximum—(*a*) number of hardest blows per minute, 100; (*b*) cubic feet of free air per minute for above, 310; (*c*) size of compressor for a single 5-cwt. hammer, in cubic feet of free air per minute, 280; (*d*) approximate power required for pressure of 45 lb. per square inch, 35 brake horse-power. Average—(*e*) cubic feet of free air per minute, 38; (*f*) approximate power required for pressure of 45 lb. per square inch, 4.5 brake horse-power. These powers are based on the assumption that the compressors require for a pressure of 45 lb. per square inch 12.5 brake horse-power per 100 cubic feet of free air per minute.

THE SHOCKLESS JARRING MACHINE

It will be remembered that in the preceding issue of COMPRESSED AIR MAGAZINE we described a portable jolting machine. This type of machine, in which sand ramming is dispensed with and the requisite solidity of mold is secured by simply raising the mold and suddenly dropping it a sufficient number of times, seems to be coming rapidly into use. Hitherto, machines of this type have been used for flasks which could be handled by one or two men, but in the nature of things there is no reason why the same principal should not be applied to molds much heavier, and accordingly we find in the latest issue of the *Journal* of the American Society of Mechanical Engineers a paper by Mr. Wilfred Lewis, of Philadelphia, in which the use of larger machines is discussed. The added complication in the handling of much heavier flasks is in the shock given to the surroundings when the drop occurs. This would be prohibitive, but it is successfully avoided in the Shockless Jarring Machine, which is the subject of the paper referred to. Our space only permits an abstract, and even this is all too long.

The jarring machine is essentially a sand-packing machine, capable of ramming any mold, large or small, in a minute or less time. By the method employed, the sand is rammed, as it should be, densest at the surface of the pattern and of decreasing density above, thus favoring the escape of gases when the mold is poured. The packing of the sand results from impact between the table on which the mold is carried and the anvil on which it drops. Various means may be used to lift the table and let it drop, but in foundry work compressed air has come to be generally preferred for its convenience as a medium for the transmission of power, and also for the simplicity of the machines resulting from its use.

During recent years, while the power squeezer and the split-pattern machine were completing their development, the much neglected jarring machine has grown steadily in favor and in size, until to-day there would seem to be no limit to its capacity. These machines are simple in construction and effective in operation, while on large work the saving to be effected by their use probably exceeds that by all other types of molding machines combined. If it takes two men eight hours to mold by hand a certain pattern, in a flask 45 in. by 60 in. by 36 in., and if five hours of this time is consumed in ramming sand, a jarring machine would save practically five hours of the time. It would not save any of the pattern-drawing and finishing time, nor any of the time for setting cores, but it would enable two men to make the mold in three hours, instead of in eight hours by hand.

The damage that may be caused by the action of the jarring machine upon finished molds, or even upon buildings in the neighborhood, and the annoyance caused by noise and ground waves generally, call for serious consideration. This damage and annoyance has increased steadily with increase in the size of the machines and in the weight of the loaded table. To meet these serious objections, various expedients have been adopted, among which may be mentioned a reduction in the stroke or drop, and a more or less resilient bedding for the anvil. These palliatives, however, left much to be desired until the shockless jarring machine, with its anvil rising up to meet the falling table was developed. This has eliminated the chief objection to jarring machines.

In the molding machine to be described, the table adopted has been formed in one piece with the jarring cylinder, as shown in section in Fig. 2. This table has great depth of

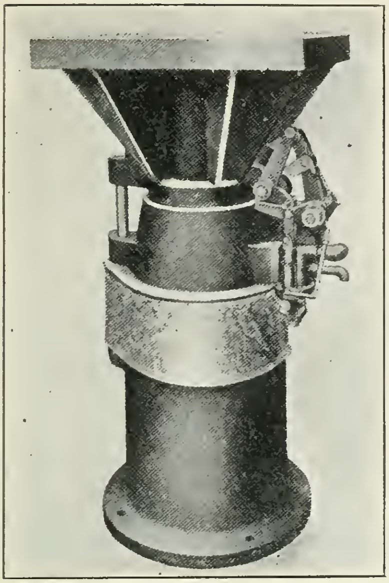


FIG. 1.

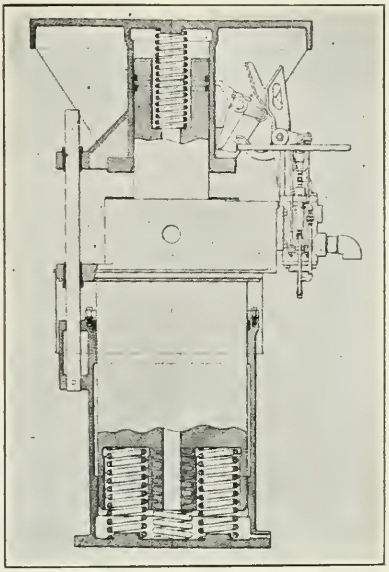


FIG 2.

beam, and the metal is distributed as it should be for economy of cast iron, in a broad expanse of plate on the tension side, and a smaller mass around the cylinder on the compression side, where the blow is struck. Radial ribs connect the tension and compression sides of the beam, forming a table of enormous strength and stiffness to distribute the central blow of impact equally in all directions. There is no perceptible vibration of the table when it strikes its anvil, or rather the buffer ring of leather, or other non-resilient material, interposed to relieve the sharpness of the blow and to reduce the noise. This buffer also helps to reduce vibration and rebound, by reducing the intensity of the force of impact. It is not, however, the rebound of the table from its anvil that injures a mold, so much as the rebound of the flask and sand from the table. Solidity of contact between table, pattern board and flask, is one of the most important elements for the successful working of a jarring machine. Unlimited power may be expended in jarring sand to any given density; and since there is a certain maximum density corresponding to any given drop, it is also quite evident that efficiency increases with the drop, and decreases with the dead weight handled over and above the weight of sand used. With air as a working fluid the benefit gained by expansion on light work offsets to a great extent the loss from the greater proportion of dead weight carried, giving to the jarring machine which uses air expansively in its cylinder quite a wide range of capacities.

The shockless jarring machine consists, in its usual form, of a jarring table mounted upon an upstanding plunger forming the anvil, which in turn is mounted in a cylinder base and supported upon long helical steel springs. Compressed air, as the working fluid is admitted through an automatic valve, under hand control, attached to the plunger or anvil base, and passes first into the jarring cylinder to raise the loaded table. At some predetermined point in the table movement, the air is automatically cut off from the cylinder, and while the valve is reversing, the confined air will expand and lift the table further from its anvil, provided its initial pressure exceeds the balancing pressure due to the weight carried. Then, when the operating valve completes its reverse movement the air from the jarring cylinder may be exhausted into the atmosphere, but preferably it passes from the jarring cylinder to the anvil cylinder beneath, and the table drops by gravity against the reduced pressure in its cylinder. At the same time, the plunger base or anvil is reliev-

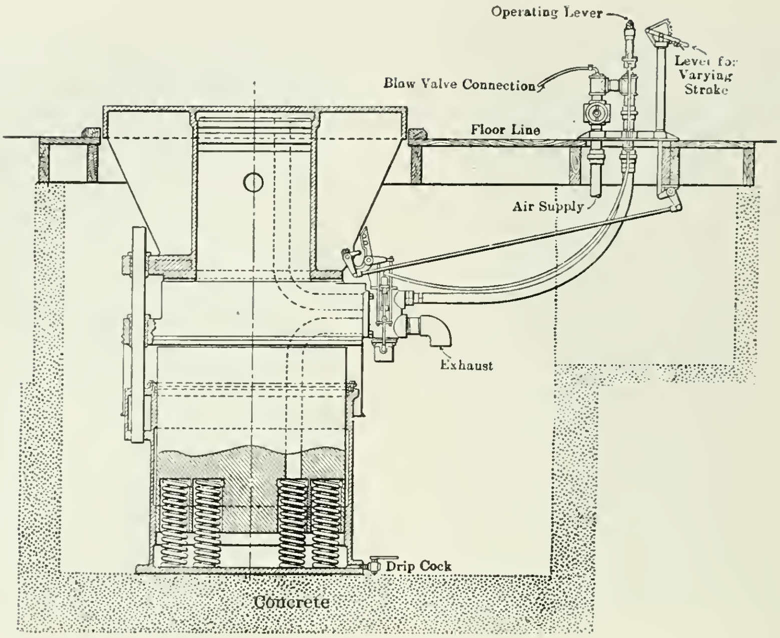


FIG. 3.

ed of a considerable part of the load carried by its supporting springs, which immediately expand, giving the anvil an upward velocity to meet the falling table. When air is expanded from the jarring cylinder into the anvil cylinder this upward velocity of the anvil is augmented and the falling velocity of the table is somewhat retarded, but in any case the momentum of the rising anvil is substantially equal to that of the falling table at the instant of impact. As a result, both table and anvil come to rest with great jarring or ramming effect upon the sand, but without shock or jar upon the foundation of any surrounding material.

When the air from the jarring cylinder is discharged at once into the atmosphere the momentum of the falling table may somewhat exceed that of the rising anvil at the instant of impact; but when this air is expanded into the anvil cylinder it compensates more or less for the loss of spring pressure as the anvil rises, and in this case the momentum of the rising anvil may exceed that of the falling table at the instant of impact. The difference, however, need not be very pronounced, and simply results in a slight initial velocity of the table and anvil at the beginning of the next stroke.

The advantage of the second expansion is two-fold: it utilizes the potential energy of the compressed air in augmenting the momentum of the anvil, and at the same time it checks the acceleration of the table due to gravity and holds it in contact with the load upon it while falling. Otherwise a poorly fitted pattern board or flask may tend to spring away from its support while falling and cause lost motion, productive of a bad mold. For the same purpose, when the air is discharged directly from the jarring cylinder, a long compression spring between the jarring cylinder and its plunger may be introduced with good effect. In several instances such springs as shown in Fig. 2 have been made to carry half the weight of the table with 8-in. compression. They assist in lifting the loaded table, and retard its acceleration in falling; and by their use the lifting capacity of jarring tables may be considerably augmented. Their chief purpose, however, is to retard the falling table and hold the pattern flask and sand firmly against it in readiness for the coming blow. With such a spring, the action of the table is, of course, somewhat slower in falling and more stroke is required to produce a given velocity of impact. On the other hand, the table rises fast-

-er and runs further to produce a given blow, and the increased stroke reduces the percentage of clearance space to plunger displacement. The spring in this position has, therefore, some beneficial effect upon the consumption of power, while serving a much better purpose, in the production of good molds, and although not so important when the air from the jarring cylinder passes through the anvil cylinder, it may be of some value in that case also.

Fig. 3 represents the design of a machine now being built for a large foundry to handle half-molds weighing 25 tons. The table is a steel casting 8 ft. x 12 ft., with lifting cylinder 3 ft. in diameter, and the plunger base forming the anvil is a solid iron casting weighing 65,000 lb. This is carried upon 22 steel springs, designed to compress 8 in. under the maximum load and to develop a working stress of only 60,000 lb. per sq. in., which is very much less than the usual working stresses on railway car springs and quite within safe limits. The total weight of the machine complete will probably be in excess of 90,000 lb. This is carried in a concrete pit designed simply to protect the machine and to support the static load on the floor of the pit.

PNEUMATIC HAMMERS IN USE

The following which we reprint (slightly abridged) from *Machinery,* written by Mr. George H. Hayes, works manager of the Chicago Pneumatic Tool Company, applies equally to all makes and styles of pneumatic hammers, and should help to secure for them appreciation and more considerate and careful treatment.

The material used in the construction of pneumatic hammers is the very best that money can buy and is the result of long periods of experimenting at an outlay of a great deal of time and money to get material that is best able to withstand the vibrations, jar and wear which pneumatic tools are called upon to withstand. The treating of the material, fitting up, and testing, must be done by experienced and competent men. Pneumatic tools are made with the most extreme care, the moving parts are accurately and closely fitted, and when the proper lubrication is neglected, which is the most unpardonable offense to which a piece of fine machinery can be subjected, the moving parts of a pneumatic hammer, will wear rapidly and in a very short time refuse to work.

Another source of trouble is sometimes located in the pipe line. Moisture carried in the air will rust the pipes and if a hammer is connected up without first blowing out the pipes a sediment is liable to be blown through into the tool, causing the valve or piston to stick. Rubber deteriorates very fast and particles of the hose may blow into the valve box and stop up some of the parts. Many times we have had hammers that would not operate, sent in to the factory, and on dismantling them found the port holes plugged up with pieces of rubber, or sediment from pipes, which when thoroughly washed out with gasoline, reassembled and properly oiled, would operate perfectly.

Another abuse is practiced in taking a hammer apart and putting it together again. Some repair men, instead of using a wrench or soft hammer in loosening or tightening the handle, use a hard steel hammer, battering the parts badly and in many instances breaking them. The finished parts should never be struck with anything but lead or copper hammers, and even when this is done, good judgment should be used as to the strain put on the threads of the handle and the cylinder.

THE SHORT PISTON TRICK.

There are many abuses in connection with the operation of pneumatic hammers which are hard to locate, one of the most flagrant being the use of short pistons in riveting hammers. The manufacturers, after long and careful experimenting, have decided on a piston of proper length to perform satisfactorily the work for which the tool was designed, and all parts are made in proportion to withstand the strain. Workmen who are anxious to perfrom their day's task in the shortest possible time, or to increase the volume of work where they work on a per-piece basis, have little or no regard for these labor-saving devices. Having discovered that pistons a fraction of an inch short will do the work more rapidly, they resort to all manner of means to secure them, even having them made in outside machine shops. They carry them in their pockets and when they take the hammer from the tool room, they substitute the short piston for the one of proper length, again making the exchange before returning the hammer. The result is that sets and handles are broken and cylinders frequently split. Where these breakages are occuring at short intervals, it would be well to detail someone to go through the shop and examine the pistons while the hammers are in use, otherwise the cause of the breakages will not be definitely located.

Some of the large plants using pneumatic tools, have adopted the practice of issuing a given tool to the same workman continually, which has had a tendency to cause better care to be taken of the tools. If breakdowns occur frequently, it enables them to compare the amount of work being accomplished by different tools, and the more careless workmen are located and disciplined. Where this practice is followed, many times when the output of the shop is being forced to such an extent as to require all tools in service, and a workman is delayed in completing his work, while the men who are more careful of their tools finish in good time, it has a tendency to cause others to exercise greater care, which accrues to the benefit of all parties interested, even back to the manufacturer.

A great majority of men who operate pneumatic hammers in the shops, know very little, if anything, about the construction of the tools, and it pays any large institution using pneumatic tools to employ a competent man to look after them, see that they are properly lubricated and returned for cleaning when through with their work. I have been in foundries using large numbers of hammers in cleaning and shipping castings, where, at the sound of the whistle the hammers would be thrown down, generally in the sand, and enough sand or grit would get into the tool, so that when the air was again turned on the piston would stick fast after one or two blows. This necessitates a cleaning of the tool causing a loss of time in its use of from twenty to thirty minutes.

WORKING IN COLD WEATHER AND ON HOT RIVETS.

In starting to drive rivets in cold weather, especially on structural or out-of-door work, the hammer should be warmed up enough to take the frost out of the steel, as a hard piece of steel full of frost is liable to break at the first blow; after a few rivets have been driven, there will be enough heat from the rivets to keep the frost out. On the other hand, never allow the temper in the rivet set to be drawn too low, as a soft set will break very quickly. When driving rivets rapidly, have a pail of water handy and put the set and end of the hammer cylinder in the water occasionally to keep from drawing the temper, or change the set occasionally.

The wearing of parts in a hammer will always take place, but the life of the tool can be prolonged greatly by proper care and attention. Crystallization of the steel takes place owing to the rapid blows of the piston and the vibration. The life of the hammer depends mostly on the care which it receives and the character of the work being performed with it. A piece of fine machinery, such as a pneumatic hammer can be ruined in a few minutes by ill usage and neglect.

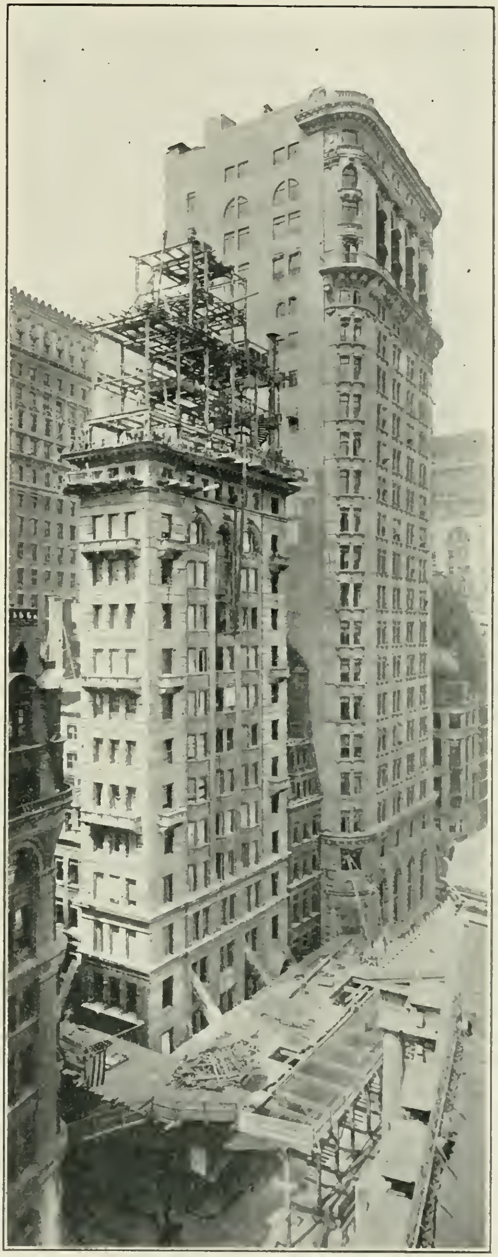
It has been proved conclusively during the past few years, that pneumatic tools are invaluable in shop practice wherein they are adaptable. Either a small or a large installation of pneumatic equipment may be the most economical in maintenance cost. The small installation does not require a special attendant, but can be looked after by the regular mechanical force, reducing the labor charge to a minimum. With an equipment consisting of forty tools or more, it should be put in charge of a special machinist whose duty it is to follow the equipment closely and to keep it in good repair. It has been clearly proved that one man can care for one hundred tools where the proper attention is given by the men handling them. We have recently had our attention directed to tools in service which have been working regularly for seven years. These tools, of course, have been well cared for, and the workmen using them appreciate their value in aiding them in their labors and handle them as they should be handled.

Pneumatic tools are outrageously abused in many cases without the knowledge of the management, and at other times with their sanction, the latter being on account of these tools having such a large earning power that they are considered an economical investment even through their life be but three months. This latter remark may seem an exaggeration; however, it is borne out by actual knowledge. One of the largest steel concerns in the world is using chipping hammers where nine hammers in the hands of men skilled in their operation easily perform work which would require ninety unskilled men with mauls and cutters. The tools in this case are appreciated by both the management and the workmen and are well cared for. Even when the tools have a short life, a great many concerns having adopted them state that the saving in wages and increased output make them an extremely economical investment.

PULLING DOWN A SKYSCRAPER

One of the most interesting of recent operations in the building line has been the tearing down of the 19 story Gillender building at the corner of Wall and Nassau streets, the very center of the financial district of New York City, preparatory to the erection of the 39 story Bankers' Trust building upon the same site, with some additional area on each street. The Gillender building was at the time of its erection, 1896, the tallest office building in the world, a typical and quite up to date steel frame erection, with pneumatic caisson foundations, costing half a million dollars, and the job of pulling down such a building had never before been encountered.

A contract was made with the Volk House Wrecking Company, 56 Beaver Street, N. Y., for the demolition and removal of the building within 45 days for the sum of $50,000 with a penalty of $500 for each day over that period. The company, having a record of over 900 buildings already removed, of course went at the work in a business way. The streets were bridged entirely across, as seen in the half tone, the covering being heavy wire netting instead of planking. Of course compressed air was employed instead of manual labor for the actual disruption of the material. Two Ingersoll-Rand, R. C. compressors were set up in the cellar and a pipe was run up with manifolds for connections at each floor, and valves which could be successively removed as the building lowered. Ten Imperial No. 5, Type E, heaviest chipping hammers were constantly in service, these being used more for cutting out the brick work, especially around the steel columns, than in the separating of the steel frame itself. Mr. Alfred Volk, in active charge of the work, says that in freeing the masonry around uprights and beams each hammer accomplished the work more rapidly than six men with sledges, bars and chisels. There were 250 men employed during the day and 100 at night, and the job as a whole was the most formidable, most rapid and most entirely successful house-wrecking feat in the world's history.



TEARING DOWN A SKYSCRAPER.

The contract for destruction and removal naturally ends at the ground level, and then the work of excavation and the sinking of the foundations begins. Although the Gillender building was supported upon pneumatic caisson foundations carried down to bed rock at a depth of about 60 feet below the curb level and these are to be entirely removed, this will not be done at the beginning. The contract for the foundations, including the removal of the Gillender caissons has been given to The Foundation Company, 115 Broadway, N. Y. Around the perimeter of the lot 15 narrow rectangular caissons will be sunk and banded together by watertight joints. these forming then an enclosing concrete wall about 7 feet thick reaching from 26 feet down to 60 feet below the street, where the rock is found, and to the rock a watertight band will be made to prevent any flow of water or quickstand into the interior of the lot. When this cofferdam is completed the excavation of the interior of the lot, including the removal of the Gillender caissons, will all be simple open air work. The new Bankers Trust building will have three full stories below the street level, the lowest to be devoted to the service of the building and the power plant, and the other two to be occupied by great storage vaults.

MINERAL RESOURCES AS THE BACKBONE OF PROSPERITY

By W. L. Saunders.

The backbone of prosperity in the United States, as in any other country, is in its mineral resources. A great agricultural country remains forever poor, notwithstanding the enormous value of the products of the land. This is because agriculture alone does not build up concentrated districts where population and prosperity contribute to the accumulation of wealth. Take India, for instance, with its enormous land values; the country produces much, but the people are poor. The same argument applies to China. Farms occupying large territories produce wealth, but the population required per acre is small and the profit goes largely to capitalists in other countries to which the product is exported. Russia, with its large fields, has always remained a poor country—rich only in the volume of its territory, but with a few large cities and comparatively little growth.

The reverse is true of England. Here we have a country with little or no agricultural opportunities, yet rich beyond the dreams of avarice. It is comomnly said that the wealth of England comes from her colonies, and this is true to a great extent, but the inherent wealth of England has enabled her to draw from and maintain colonies. It is because of the mineral resources of England, together with her vast shipping interest, that this small territory has maintained its supremacy in the world.

The United States occupies a unique position, in that it contains both agricultural and mineral wealth, the two combining to place the country upon a footing as a great manufacturing community. Agriculture without mineral resources does not build up manufacturing interests, but mineral resources alone may produce a great manufacturing country, because the product of the mines added to that of the works produces wealth sufficient to enable the proprietors to buy food from other parts of the world. England, without her ships, would not have made such progress. The United States does not need the ships, because it is not necessary for her to go beyond the limits of her own soil to produce practically everything which goes to make up the prosperity of her people.

To go further in illustrating the importance of mineral resources, let us take the State of Pennsylvania and compare it with Massachusetts, Connecticut or other States of the Union. It has been said that one might wall in the State of Pennsylvania and live in prosperity and happiness without calling upon any other State to furnish any of the sinews of life. See how rapidly Pennsylvania has progressed and to what extent the State has accummulated wealth as compared with other even older States of the Union. The great coal fields of Pennsylvania, combining with her iron and other mineral products, have been the real source of her wealth. England may well be compared with the State of Pennsylvania. The wealth produced by the English coal mines and the iron from the Cornwall district have built up her manufacturing interests and have laid the initiative in developing her resources and in adding to her wealth.

We seldom realize what the mineral resources of the United States have done in enticing immigration and in building up the country. The Argonauts of '49 trekked across the desert plains of the West to the deserted and barren fields in California and Nevada, but the gold and silver which drew them there were the real foundation stones which made the great West what it is to-day. Does anyone realize the enormous growth of the Northwest since the discovery of gold in Alaska? Seattle, Tacoma, Spokane, Portland and other cities in that vicinity have boomed beyond the dreams of anyone, not because of any special advantages in these communities not possessed by others to an equal degree, but through the great advertisement of gold in the West, followed up by the actual product which has been taken out of these fields.

There is no section of the United States so blessed in natural resources as the South. In agriculture it has broad and rich fields, not only for the production of food of all kinds, but with the added wealth of cotton and tobacco. The South is also a great mineral country, with an abundance of coal, iron, marble, granite, etc. It is near the center of population, close to navigable rivers and harbors, it has railroads traversing its fields, and yet the South has not progressed as the natural advantages of the country would warrant.

Why is it? The answer is, that the country was devastated by a fierce civil war which destroyed its population and wealth, and from which it has taken at least a quarter of a century to recover. It is a conservative statement to say that the Civil War set the South backward at least 25 years, and the results of the Civil War have still further retarded the growth of this section. By results of the Civil War I mean particularly the political conditions, between whites and blacks, a struggle for supremacy, which has resulted in drawing party lines sharply. Any community where there is a preponderance of one political party is put at a disadvantage before the world, especially so when seeking capital. We see this in commercial affairs every day. An issue of bonds is made, and the capitalist who is asked to subscribe looks into the collateral security behind the bonds. He studies the ratables, and the price of the bond is fixed accordingly. Where a community is rich, prosperous and peaceful the bonds bear a premium; where conditions are disturbed by insurrections or political disturbances the value is reduced accordingly. This is seen in the high rate of interest paid on Japanese and South American securities, and where interest rates are high there is always an indication of discouragement of capital to develop resources.

Time alone can heal the blight of the South, and those of us who love the country should rejoice in the prospect which is before us. Conditions are certainly improving, as, in fact, there has been a steady improvement for a long period of time. No artificial stimulus could have changed the situation, because the war and the results of the war produced a condition which was beyond the power of human effort to overcome, except through a period of time.

The wealth is there, and has always been there, and, in fact, it is greater now than ever, because the old mines of the world are being worked out, capital is looking for new fields, and, besides, there is an enormous increase in the demand for mineral products. In addition to this, transportation facilities have been increased. To give one an idea of the increased value of the mineral products of the United States it is only necessary to refer to the reports of the Geological Survey, which show that between 1899 and 1908 the output of pig-iron, for instance, has increased in value from $245,000,000 to $254,000,000, while silver (in which the South has no special interest) has decreased in the same period from a little less than $33,000,000 to $28,000,000; gold has increased from $71,000,000 to $94,500,000, while copper shows a growth from $101,250,000 to nearly $124,500,000. Bituminous coal, a product of the South, has increased from $167,900,000 to $374,100,000. The output of stone, an important product of the South, has doubled in value in the period stated.

Minerals laid in ores of low grade, which a few years ago were comparatively worthless because of the cost of reduction, are now valuable. This applies particularly to iron, coal, gold and copper, and it is a reasonable supposition that as time goes on still further improvements will be made, thus bringing into the world's market mineral properties which now lie dormant.

A remarkably fast piece of track-laying was recently accomplished in Syracuse, N. Y., on the Syracuse, Lake Shore & Northern Railroad, when 3,720 ft. of 56-lb rail, weighing a total of 69, 440 lbs., was taken out and replaced with 70-lb. rail, weighing a total of 86,800 lbs., in 21 minutes and two seconds.

NEW YORK MUNICIPAL OFFICE BUILDING.

NEW YORK MUNICIPAL OFFICE BUILDING FOUNDATIONS

Building operations on the most stupendous scale are familiar features of New York City progress, and perhaps never more so than at the present time. Erections making new world records are in progress and more are being planned and contracted for, both public and private interests being represented. A railway station the most extensive and costly in the

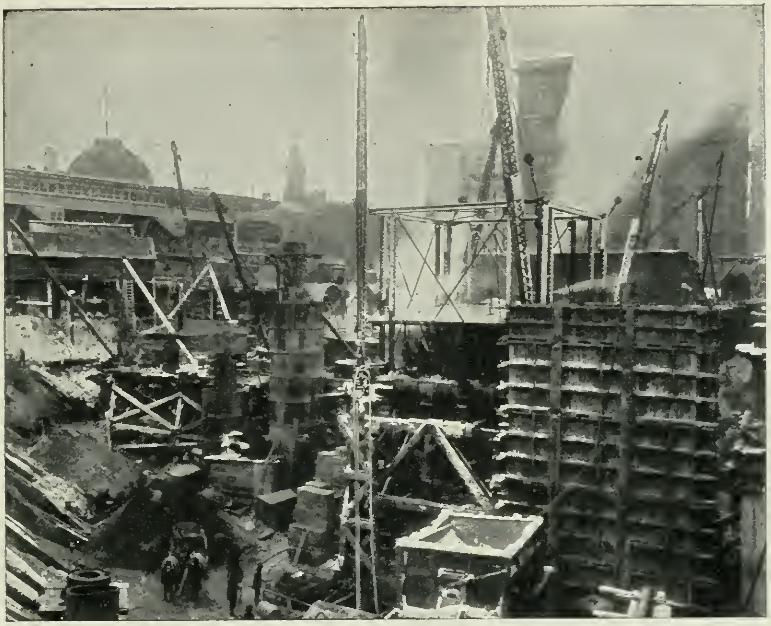


FIG. 2.

world has been recently completed and another which promises to surpass it is being rapidly pushed. There is a new courthouse of colossal size to be erected when a site can be determined upon and the plans adapted to the location.

Our present interest is in the new municipal office building seen in Fig. 1. This will be within a hundred feet of the Brooklyn Bridge terminal and will be surrounded by the most crowded thoroughfares. It will cost over $7,000,000, housing all of the New York City Departments, except Police, Fire, Docks, Ferries and Health and will reach to a height of thirty-four stories, 540 feet above the curb.

The height and weight and the permanent character of this structure make most secure foundations imperative, while the location presents peculiar difficulties, being all of the loosest sand formation. The lot area covers over 44,000 square feet. Work upon the foundation has been in progress now for many months and attracts wide attention by the vastness and difficulty of it and the unusual methods adopted.

Much caisson work is involved and for the supply of air there are employed three Ingersoll-Rand compressors and one of the McKiernan Drill Co., with a combined capacity of 18,000 cu. ft. of free air per min. There are in all 116 caissons to be sunk to an average depth of 145 feet to reach bed rock. The rectangular caissons range from 5ft. 6 in. x 11 ft. to 28 ft. x 33 ft., and the cylindrical ones from 5 ft. 6 in. to 14 ft. 2 in. in diameter and when sunk and completed, they will contain 55,000 cubic yards of concrete, requiring 233,750 bags of cement.

The Foundation Company's round, oval and collapsible horse shoe shaft, built in sections, has ben adopted for sinking the separate caissons. The accompanying illustrations show as well as possible the work in progress, Fig. 2 being taken from near the street level and Fig. 3 down in the excavation. The cellar bottom is within a few inches of tide water level and there is a considerable and constant seepage of water which must be pumped to the sewers above, and several large Cameron, Vertical Plunger, Sinking Pumps are employed for the purpose, these being operated by compressed air. In both half tones may be seen how those pumps are suspended from the hook of the derrick to be lowered as required at a moment's notice. The vast area of course is sub-

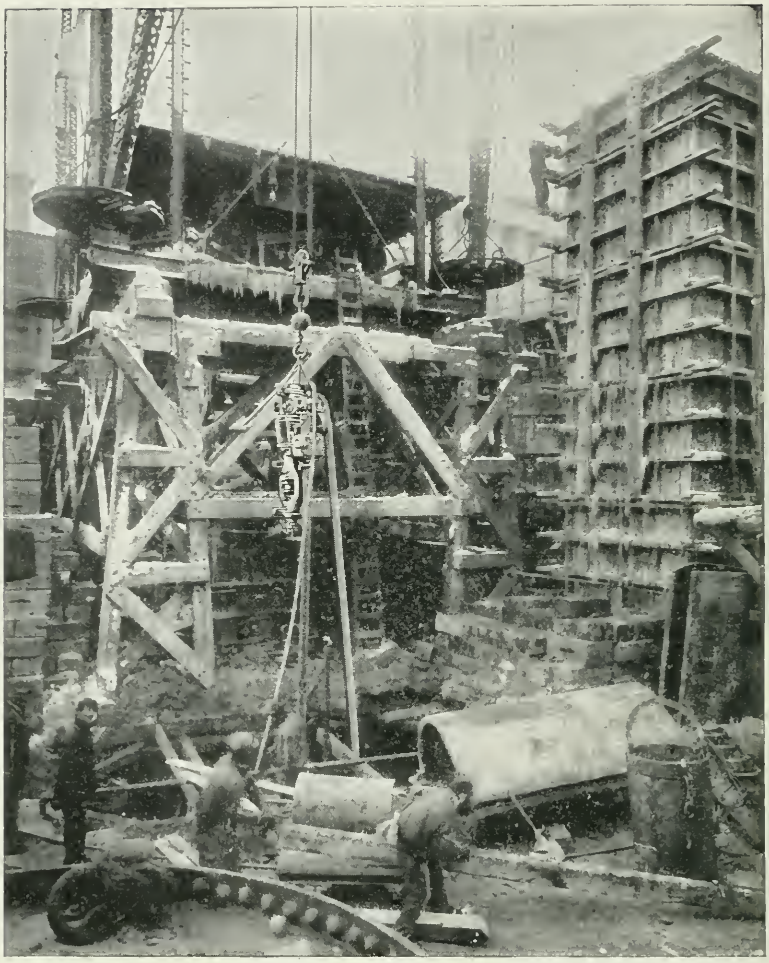


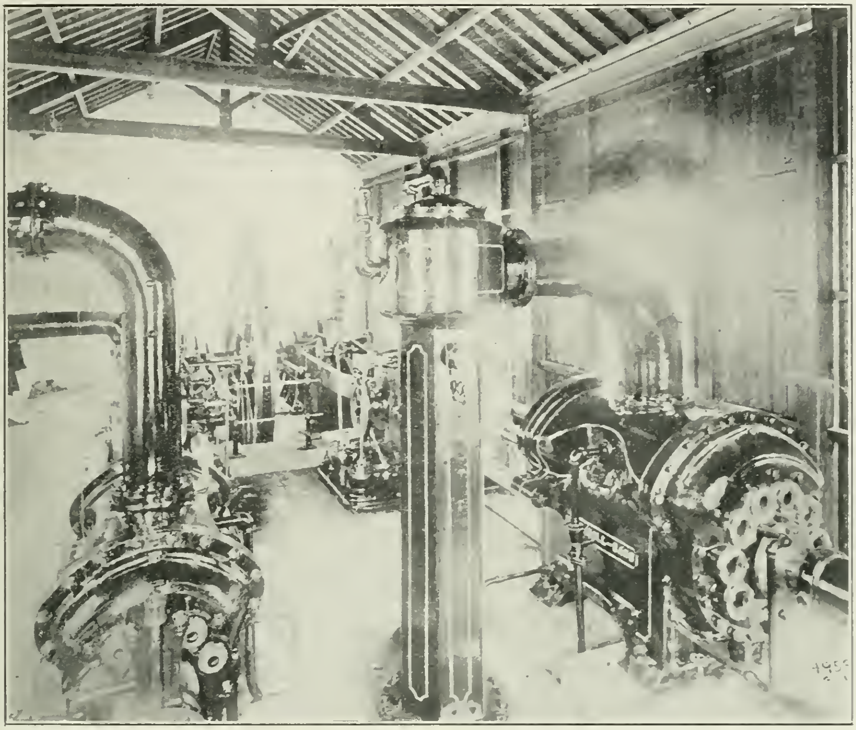
FIG. 3.

ject to large accumulations of water from rain, snow and surface flow and this also is taken care of by a number of Cameron Station Pumps located at different points.

A CAISSON PRESSURE RECORD.

Upon this work a new pressure record has been made. A caisson for one of the column piers was sunk through the sand to rock at a depth of 112 ft. 1 in. below water level without accident or casualty of any kind. The caisson, of concrete cast before sinking, and having a reinforced cutting edge, supports a concrete shaft 10 ft. 9 in. in diameter. The maximum pressure in the chamber was 47 pounds, gage. The work was executed by 20 five-man shifts working about 40 minutes each, with a very long time for decompression and an interval of 4 hours between the two shifts which each man worked daily. The men were under very strict physical and medical supervision, improved sanitary and hospital appliances were at hand and a competent physician was in constant attendance, and not even a single case of the bends occurred. This, the maximum for this building, is believed to be the deepest pneumatic caisson ever sunk.

"The Foundation Company" is the contractor and employs a double shift of men working day and night. L. I. Brown is the general superintendent and W. S. Downing is superintendent in immediate charge of the work.



AIR COMPRESSORS AT ASTLEY GREEN COLLIERY.

DIFFICULT SHAFT SINKING

Some idea of the cost and difficulty of opening and operating a coal mine in England may be gathered from an account of the sinking of the shafts of the new colliery of the Clifton and Kersley Coal Company, at Astley Green, near Manchester, as given in a recent issue of *The Iron and Coal Trades Review*. This will be one of the deepest mines in Great Britain as the shafts are to be carried to approximate depths of 950 and 1,150 yards respectively, the depths sunk at the present writing being 259 and 149 yards. The work of sinking has been in hand two years, but for five months of that period, sinking operations were entirely suspended during the erection of the plant necessary for the installation of the drop shafting, so that, bearing in mind the peculiar difficulties contended with, the progress has been remarkably rapid. The bore-hole, which was put down in close proximity to the site of the downcast shaft, with the idea of utilising it to help to clear the shaft of water during sinking, revealed the presence of about 94 ft of silt, immediately underlying the surface clay some 36 ft. thick. Unfortunately, one of the pipes fouled the hole during boring operations, and the cutting out of this made the bore rather worse than useless, so far as sinking was concerned; in fact, the disturbance occasioned was considered mainly responsible for the heavy inrush of sand which was experienced at one point in the work, and which, but for the exceptional provision made above ground, might easily have resulted in the loss of the shaft.

Before commencing to sink, Mr. Percy L. Wood, general manager to the Company, spent some time in Germany, visiting the collieries and studying the methods adopted in that country, he then came to the conclusion that the best means of getting through the silt was the freezing process, or, alternatively, by means of drop shafting. The first-named process naturally involves a heavy capital outlay: seeing, therefore, that the clay bed promised to afford an excellent foundation for the auxiliaries, the Company decided to sink by drop shafting.

Sinking operations through the clay proceeded in the usual manner, and the shaft made 23 ft. in diameter, which size was continued to the end of the drop shafting; this was to allow for possible deviation from the vertical, and to correct same, if necessary; the shaft below the cutting shoe being 21 ft. in diameter. Having completed the lining of the shaft passing through the clay, a concrete pillar, strongly reinforced with old rails and bars, was built round the shaft, encasing the brickwork.

The base of this pillar was at 51 ft., and its height clear out of the ground 18 ft.; its first duty was to carry the pressure ring, but it also forms the permanent landing level. The head gear was next got into position. An electric crane was installed which served to place the sections of tubbing in position, after they had been delivered by a locomotive jib crane.

The pressure on the cutting shoe was obtained from 12 hydraulic jacks, giving a total pressure of 20,000 tons. It is worthy of note that after the completion of the pushing-down the edge of the cutting shoe remained in perfect condition, which speaks well for the design as also for the constructive material employed. The shoe was, however, left in position, as, owing to the nature of the strata, it was considered too risky to attempt its removal, and the conical or reducing rings were joined directly up to it. From this stage until the stone measures were reached, sinking was done by means of underhanging tubbing. The hydraulic jacks were first put into service on September 21, 1908.

On October 27, the foundation of the concrete block was laid bare on the borehole side, when a subsidence of some 9 in. was found to have taken place; this was filled up with concrete. A couple of days later the ground had fallen away a further 3 in., and to make good this subsidence some 36 cwt. of concrete was teemed in. This falling away and subsequent filling up with cement continued in a diminishing degree daily until November 6, after which no further subsidence was observed.

The first feeder of water was reached on March 10, 1909, at a depth of some 94 yards, and a second feeder was reached some 10 days later. Two pumps were installed to deal with the water during sinking, one of which was equal to the total duty, the other acting as a stand-by. One of the chief advantages of the underhanging tubbing process is the fact that the feeders are tubbed off as met with. This was forcibly illustrated at a depth of 105 yards, when, before the holes above the ring were plugged, 29,500 gallons of water per hour had to be pumped, and this, by means of the tubbing, was reduced to 5,000 gallons per hour, the water pressure being 92 lbs.

The tubbed portion of the shaft has a very neat and workmanlike appearance, and at the present time the bottom of the shaft is quite dry, though there seems every probability that a heavy feeder will be tapped somewhere in the neighborhood of 400 yards, which will, of course, have to be pumped.

The only permanent portion of the plant installed at the time of our representative's visit was a fine pair of air compressors by the Ingersoll-Rand Company. These, which we illustrate are of the cross-compound Corliss type, having compound condensing steam cylinders 17 in. and 38 in. in diameter, with compound air cylinders 32¼ in. and 20¼ in. diameter and a stroke of 42 in. The machine is fitted with the makers' patent piston inlet valves and poppet-type discharge valves. Its maximum capacity is 3,183 cubic feet of free air per minute, running at 78 r.p.m., with a maximum steam pressure of 160 lbs., and a maximum air pressure of 100 lbs. The total indicated horse-power is 560.

TUNNEL DRIVING RECORDS

At at recent meeting of the Railway Club of Pittsburg, Mr. R. B. Woodworth read a paper upon tunnel design and construction in which he brought together a number of the most notable tunnel driving records. The interest in speed records in rock tunneling is due to the fact that the time needed to complete the entire tunnel, and consequently the period during which vested capital lies idle, is wholly dependent on the speed with which two small headings can be put forward; only a very small party of men can work in each heading and concentration of working forces is not possible; therefore, engineering construction looks upon speed of work in tunnel driving as an item of supreme importance. High efficiency of tools and methods and careful attention to the prevention of delays of whatever character are the main features in the determination of tunnel progress. Natural conditions may, of course, affect the work, such as unfavorable direction of strata, fissured rock, presence of water, etc. Where the rock is firm, solid and dry, one month's work may be double the ordinary rate of advance. The record for high tunnel driving is now held by the Alpine tunnels, such as the Simplon, the Arlberg and the Loetschberg. The greater length of these tunnels and the possibility of installing a more perfect plant and a more thorough organization may account in some measure for the comparative supremacy over English and American records.

The Joker Drainage Tunnel, Red Mountain, Colo., 5,055 feet long, was driven 282 feet in its best month, July, 1904, through Andesite breccia. The heading was 12 feet by 11 feet timbered 8 feet 6 inches by 7 feet.

The drainage tunnel at the Iron Mountain Mine, Superior, Mont., 5853 feet long, was driven in 7 feet by 6 feet heading through quartzite 288 feet in one month, January, 1907. Average rate for the entire tunnel 233 feet per month. Cost per foot, $14.50.

The 6 feet by 9 feet heading of the Newhouse Drainage Tunnel, Idaho Springs, Colo., 22,000 feet long, was driven 290 feet in May, 1906, through granite and gneiss.

The best progress made in the construction of the Roosevelt Drainage Tunnel at Cripple Creek, Colo., 15,550 feet long, was 435 feet in January, 1909. Average monthly advance for twelve months, 292 feet. The heading was 10 feet wide by 6 feet high with a 3x6-foot drainage ditch on one side of the floor, the muck was taken out in steel cars of 36 cubic feet capacity on a single track railway in trains of 10 to 12 cars hauled by mules.

The Gunnison tunnel, an essential part of the Uncompahgre valley reclamation project, is the longest irrigation tunnel in the world. It is 30,582 feet in length and the headings were driven to a meeting point on July 6, 1909, as the culmination of 54 months' continuous work. The best record made was the driving of an 8x12-foot heading 842 feet in one month in soft shale. The best record in granite for any single month for one heading was 449 feet, January, 1908. The record headings were driven by the under-cut method.

The Elizabeth tunnel of the Los Angeles Water Works, California, 26,860 feet long, was driven 466 feet in granite in October, 1908. The heading was 12x12 feet, the mucking being done by hand and the tramming by electric motors. Cost per foot, $31.81.

An excellent record in driving a railroad tunnel was made in 1908 on the Bitter Root tunnel of the Chicago, Milwaukee & St. Paul Railroad, through the Bitter Root mountains, Montana. The tunnel was driven by the regular top heading method and was advanced 563.5 feet in May of 1908, the average advance for the three months of March, April and May being 499.7 feet. The rock is a quartzite somewhat laminated and the heading is the full roof arched section for a double track tunnel.

The new Croton Aqueduct has a length of 30.87 miles, of which 29.63 miles is in tunnel, being horseshoe in form, 13.53 feet high and 13.6 feet wide and carrying an estimated capacity of 318,000,000 gallons of water per day. This is the longest tunnel in the world. It was driven from shafts about a mile and a quarter apart along the length of the line, and the best record in any one heading was 550 feet per month. This was in hard rock in an unusually large heading and the ordinary progress was about 175 feet per month.

The bottom heading of the Loetschberg tunnel, 6 feet 6 inches high by 10 feet wide, is driven by machine drills mounted on drill carriges, and the rock encountered varies from granite to gneiss and is hard drilling. The record in this tunnel is 574 feet in September, 1907. Average speed for five months, 555 feet per month.

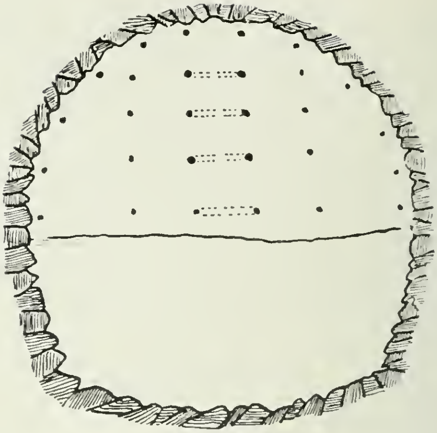
A record of 579 feet during the month of May, 1909, has been made in the Fernando tunnel, located about 25 miles north of Los Angeles and driven in connection with the construction of the Los Angeles intake through soft sandstone. The tunnel has a section of 10 feet 8 inches by 11 feet 2 inches, and the whole section is carried forward in one operation by three shifts of sixteen men each. The completed tunnel will be 9,112 feet long.

The Arlberg tunnel, in the Alps, 33,696 feet long, was advanced through schist and gneiss 641 feet in July, 1883. The average speed of driving for 40 months was over 400 feet per month.

The world's record for rapid tunnel driving is held by the Simplon tunnel, 64,818 feet in length, in the construction of which a heading 6 feet 6 inches by 9 feet 8 inches was driven through schist and gneiss 755 feet. This figure was made in July, 1904, in the south heading, the best speed in the north heading being made in December, 1902, at the rate of 682.2 feet. In both headings the work was interrupted and delayed by bad rock, the average rate of speed of 426 feet per month for 76 month's being exceedingly good.

CLEAN AND RAPID TUNNEL WORK

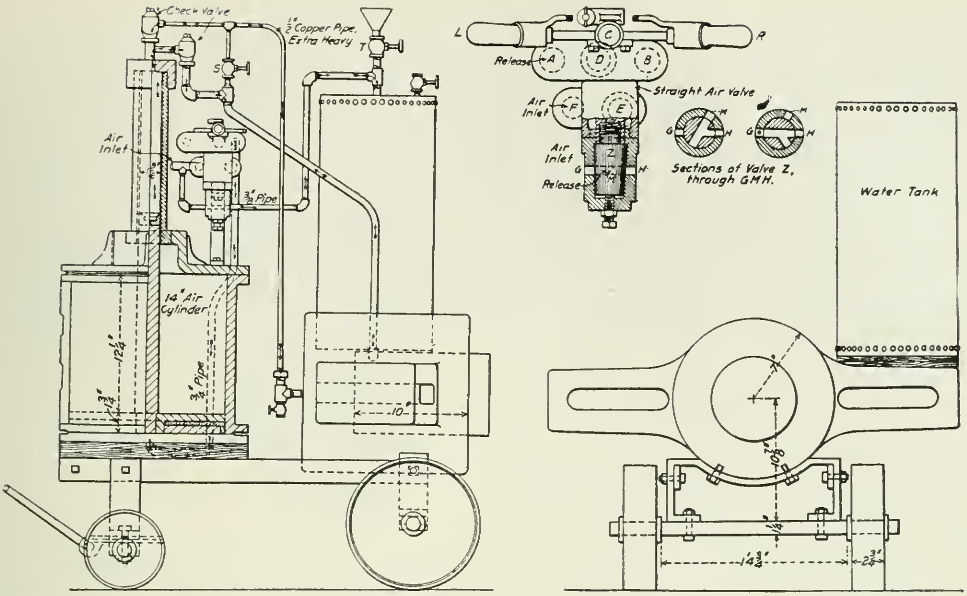
An interesting example of what can be accomplished by the judicious use of powder and gelatin is to be found in the Southwest Lake and Land Tunnel, at present under construction for the city of Chicago. The work in connection is being done by George W. Jackson, Incorporated. At the present time this tunnel extends one mile and a half under Lake Michigan, the entire bore being through tough limestone. When completed the tunnel will extend 11,000 feet under the waters of the lake and 1,265 feet under the land side, making a total of 12,265 feet. The estimated cost for the entire piece of work is $1,581,090. The work is being done by means of blasting, the tunnel section in the rough being about 16 feet, and the customary heading and bench methods are being employed. The heading and bench are about equally divided, and four Ingersoll-Rand air drills mounted on columns are used in the heading, equipped with cross bits. From April 1 to May 1, 1909, in twenty-seven working days there were driven in the heading 468 feet, establishing a daily record of 17½ feet, which is considered the world's record. There are eight center cut holes, with four helpers on each side, while to force the remnant twelve rim holes are drilled around the outside. The bench is removed with eight vertical holes, no lifters being used. In order to break this it requires an average of 225 pounds of 60 per cent. Du Pont gelatin. It takes an average of one and one-half hours to blow out and load the holes, which are filled about three-quarters. The men work in two shifts, shooting each shift. Each driller has a helper who arranges steel and makes himself useful in a general way, though generally manipulating the feed screw. The charge is set off electrically, the current from the 110-volt light circuit being used for that purpose. When the blast has been made, a blower is turned on which quickly sucks out the gases remaining in the bore. A feature in connection with this work is the fact that few noxious gases are generated by this type of gelatin. The drillers do their own mucking back for the set up, and in turn are assisted by the muckers in tearing down. Very complete reports are kept of this work, a record being turned into the office every hour showing the distribution of all forces and covering every portion of the work. This system was introduced to catch the least leakage in the matter of cost. One blacksmith is sufficient to keep both shifts supplied with the necessary steel.—*Contractor.*



PLAN OF HEADING HOLES.

AIR OPERATED PORTABLE HYDRAULIC PRESS

The cut herewith, adapted from *The Railway Age Gazette,* shows a handy and time saving wheel press designed by John Horne, draftsman at the "Burlington" shops, St. Joseph, Mo. There is a 14-in. air piston and a 1 9/16-in. hydraulic plunger moving with it, the latter forcing water into the ram cylinder in the usual way. The air cylinder is operated by manipulating the valve, which is shown in enlarged section to facilitate explanation. When the handle is in the center, air is cut off. The handle in position R opens valve E and closes valve D, making connection to the 14-in. air cylinder through F, E, B, as shown by arrows, also closing air inlet in valve Z



PORTABLE AIR OPERATED HYDRAULIC WHEEL PRESS.

at G and making connection through H and M to the atmosphere, as shown on section of valve Z at G, M, H, raising the 14-in. air piston and the 1 9/16-in. water piston, forcing water into the ram. The handle in position L closes valve E and opens valve D, making connection B, D, A from the 14-in. air cylinder to the atmosphere; also opening the air connection on valve Z through G, H, as shown on the section of valve Z, to the top of the water tank, forcing water through the pipe at the bottom of the tank to the top of the 1 9/16-in. piston, forcing the piston down and filling it with water ready for another stroke. Each stroke moves the ram 3/4 in. To force the ram back, put the handle in the center and open globe valves S, T.

HOT AIR SHOWER BATHS

Electric hot-air fans have been employed for some time in medical practice, and have undergone during the last few years most interesting alterations as regards form and use. In their original form they were used for drying hair by means of an air current produced by an electric fan, and heated by an electrical resistance.

This current of heated air was soon found to possess striking curative effects. In connection with maladies such as gout, rheumatism, neuralgia, etc., a daily application lasting ten to fifteen minutes would alleviate, and in the case of prolonged treatment, even cure these ailments. It is true that the limbs affected, being especially susceptible to cold after the treatment, had to be carefully protected by warm clothing.

Some time after the new treatment had been introduced in medicine, hot-air currents were found to exert striking curative effects on morbid tissues, and in furunculosis, abscesses, etc., on account of the hyperæmia (abundance of blood) produced by them. Thus, hot-air shower baths have been adopted in an extremely short time, not only in hospitals and sanitoria, but in the consultation rooms of specialists, as well as those of the ordinary practitioner. Their ease of handling, the readiness of the hot-air fans for use in working at a moment's notice, after being connected with an ordinary contact box, and the control of the heat effects at will by a special switch, have greatly facilitated the adoption of the shower baths. In fact, hot-air ventilators are able to generate in half a minute a strong air current up to 212 degrees F., a result impossible with any other apparatus.

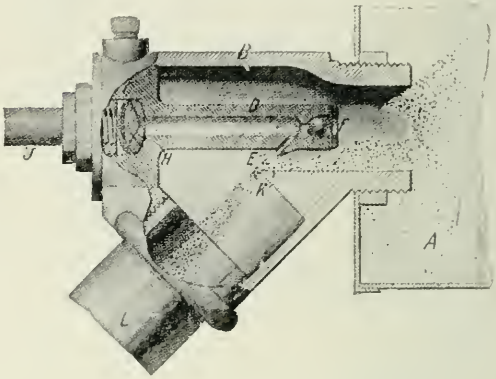
The electrometrical instrument factory of Dr. Richard Heilbrun in Berlin has recently extended the use of hot-air shower baths to veterinary practice. The ventilator used in this connection comprises a series-wound electromotor hidden in the handle of the apparatus. The electrical radiator heating the drawn-in air current to a temperature up to 212 degrees is carried by a connection tube 40 millimeters (1.5 in.) in diameter. The weight of the apparatus is about 2 pounds; the current consumption of the motor under a tension of 220 volts is 0.2 ampere, and that of the radiator 2 amperes. A nickel funnel, 100 millimeters (4 in.) in length and 20 millimeters (¾ in.) in diameter, fitted over the mouthpiece allows a hot-air current of increased intensity to be generated, which is particularly valuable in connection with a localized treatment. As dogs and horses are especially susceptible to catching cold, the hot-air shower bath affords an effective means of alleviating and curing their ailments, even the most nervous dogs becoming accustomed to the unusual treatment after its first application.—*Scientific American.*

COMPRESSOR VALVE RESPONSIBILITY

A short time ago the superintendent of a plant in a nearby town requested me to come over to determine, if possible, what was wrong with his air compressor. It was a duplex steam and two-stage air machine running at about 150 revolutions per minute and controlled by a combination speed and pressure governor. The air receiver had not yet arrived and the compressor was discharging direct into the line. When running at full speed it took considerable time to get the pressure up to 90 pounds and after this point had been reached the compressor continued to run at about 100 revolutions per minute. When the machine was shut down the pressure in the air line fell very slowly, which indicated that the leaks in the line did not amount to much; so it was plain that the compressor was not handling as much air as it should.

While the compressor was running I opened the safety valve on the inter-cooler and there was no pressure in it, showing that the first-stage cylinder was not compressing any air. We accordingly took out the discharge valves and found that one was broken and the rest so badly stuck to their seats that it took considerable work to get them loose, most of them having been closed tight against their seats. One set of inlet valves was also taken out and cleaned, and when all the valves had been overhauled, and replaced, the compressor was started again.

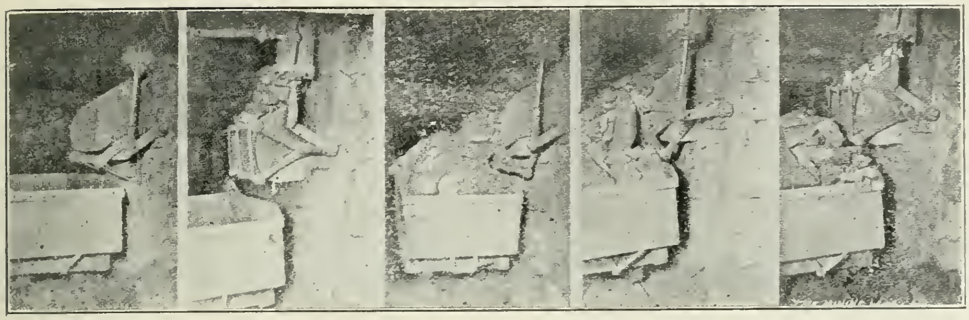
This time is worked satisfactorily, and when the pressure was up to 90 pounds it slowed down to 25 revolutions per minute.—*Power and the Engineer.*



IMPROVED TRACK SANDER

This apparatus, it will be seen, employs two jets of compressed air, one of which is directed against the sand in the box to agitate it, while the other acts to continuously expel the sand. In the cut *A* is the sand box and *B* is the sander casing which is substantially of Y form. At the rear of the casing is a plug *C* with an inwardly extending nozzle *D*. This nozzle is constricted at the end to form a jet opening into a recess in which a ball *F* is placed. There is a screen at *H* which strains the compressed air which enters by pipe *J*. The small jet opening *E* in the side and near the front of nozzle *D* will be noticed.

In the side branch of casing *B* is pipe *L* for delivering the sand upon the track. Within the casing and extending partially over the passage leading to pipe *L* is a shelf *K*. When air is admitted through pipe *J* it forces its way past the ball *F* into the sand box. A portion of the air is at the same time directed backward through the jet opening *E* producing a partial vacuum, which causes the sand which is agitated by the main jet to flow along shelf *K* and then it is carried down the delivery pipe *L*. The ball *F* prevents the constricted opening in the nozzle from being clogged with sand, and this constricted opening serves to reduce the fluid pressure by permitting its expansion past the ball *F*, so that a destructive sand blast effect is avoided.

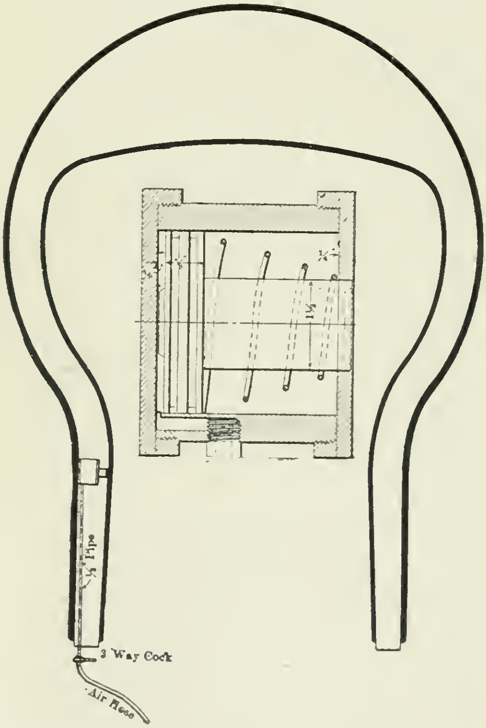


AIR OPERATED GATES ON ORE CHUTES

The half tone here reproduced from *The Mining World* shows a valuable labor saving device in use in the Crean mine of the Canadian Copper Company. Some careful engineering is required at this mine to provide convenient dumps for the rock rejected on the back stopes. With this object in view the stopes are carried one ahead of the other (*i. e.,* one higher than the other), in the form of terraces, the stopes being advanced in opposite directions to the fills, the reject of one stope forming filling for the succeeding ones. The ore-bearing rock is transferred from the chutes to the tram cars by means of air-operated gates, devised by the management (see illustration). The gate is hung radially to the lip of the chute, on a square shaft placed underneath the bottom of the lip, and held in position by means of arms which are integral parts of the gate. The bottom of the lip is about 1 ft. above the side of the tram car. When the gate is open it swings under the lip. The stream of ore flows into the car until it blocks. The car is filled to its full capacity, heaped up, but no overflow occurs. The air is turned on and the gate cuts through the pile of coarse rock, separating the rock in the car from that in the chute. No adjustment of the load is necessary. No delay occurs. Unless the chute happens to be blocked, the whole operation of loading does not consume one minute. Tram cars and skips each have a capacity of three tons, both designed to run continuously and withstand the excessive hard usage to which they are subjected.

PNEUMATIC RIVET HOLDER

A correspondent sends to *The Boiler Maker* this sketch of a pneumatic device for holding-on when riveting in close places as in the boiler leg here shown. The piston is 3 inches diameter and the thickness of the holder closed is 3½ inches. The travel of the piston, or the limit of extension for holding-on is a little over 2 inches. An air pressure of 90 pounds was available for operating.



COMPRESSED AIR QUICKENS A HYDRAULIC PRESS

There is nothing so useful around any shop as compressed air. In a certain railroad wheel shop the car-wheel work increased on the three wheel presses to such an extent that we were unable to handle it in 10 hours, and I was ordered to investigate as to what improvements could be made.

I noticed that there was considerable time consumed in pumping the ram up to the work, although we had low- and high-pressure pumps on all of our presses. To increase the speed of the ram, I placed an old air reservoir under the floor and attached the air pipe as per sketch. This increased the output as much as 10 or 12 pairs per 10 hours.

There are no changes to make to the pump, as the water is simply pushed through the old intake connection. The air can remain while the pump is working, but it is best to release the air early, so that the ram will return promptly.—*W. A. Antlomy in American Machinist.*

CROOKED AIR-LIFT EXPERIENCE

The following is the experience of a correspondent of the *Southern Engineer*:

Last summer our bored well caved in and shut off our water supply. The well was located in the engine room and had been in use 15 years without giving trouble. It was 250 feet deep, 4½-inch standard pipe casing open at the bottom, with no strainer. We pumped water with air and got 90 gallons a minute, the total lift being 290 feet from the well to the top of the building, the tank being directly over the well. The roof of this water stratum fell in, and as there was no strainer the mud and sand rushed up in the well as fast as we could pump it out. A new well was sunk outside the building. This was 4 inches, 250 feet deep, with 30 feet of 2½-inch strainer at the bottom. The new well flowed 80 gallons a minute on the test run, the water flowing out on the ground. But as the well is 60 feet from the old one, the discharge pipe had to be run at an angle of 45 degrees to reach the tank. With this pipe arrangement we could only get 50 gallons a minute, but we finished the season, and next season we will use air to raise the water to the ground level and then a piston pump to discharge into the tank. It does very well to raise water with air as long as you can keep it going straight up, but when the discharge pipe has to be run at an angle, the water will fall to the bottom of the pipe and some of the air will pass over it, allowing some water to run back into the well.

The annual per capita consumption of coal in the United States constantly increases. In 1880 it was 1.4 tons per capita; in 1892, 2.3 tons; and in 1907 it was 5.4 tons.

VENTILATING WITH COMPRESSED AIR

The practice of turning compressed air into a ventilating pipe to induce an air current is quite general in the Cœur d'Alene mines. This is undoubtedly the simplest method of ventilating drifts when compressed air is at hand and power to operate a fan blower is not available. On the 1,200-ft. level of the Hecla mine at Burke, air is drawn in this manner 500 ft. from the face of a drift to the shaft. Twelve-inch pipe is used and a piece of ¾-in. pipe turned up at the end serves as the air nozzle. The air current is in this instance sucked 500 ft. through the fan pipe, the air jet being introduced into the fan pipe about 15 ft. above the bend at the shaft.

A different scheme is used on the 1,600-ft. level of the Mace mine. Here the air jet is applied within a few feet of the suction end of the fan pipe. In this manner a current of air is forced 400 ft. to the shaft through 8-in. fan pipe. The nozzle is, however, different in this case, being made of ½-in. pipe bent in circular shape so as to just fit around the interior of the fan pipe. The coil is drilled with a number of ⅛-in. holes on the side opposite the suction end of the fan pipe. It is claimed that this acts as a more efficient nozzle and requires much less air than does turning in the air in a single jet. These nozzles may be used at a number of places in the fan pipe if one will not draw a current of air sufficient for proper ventilation.—*Engineering and Mining Journal.*

From being originally a very simple proposition the manufacture of high-grade tool steel has become one of the most complex metallurgical problems known to science. The up-to-date steel maker searches the entire world for material to make these complex alloy steels: manganese from Russia, silicon from France, chromium from Germany, tungsten from Colorado, Spain and Australia, vanadium from South America—in fact, no corner of the earth is overlooked, and the search for steel-making materials is as thorough even as the search for gold.

The lowest atmospheric temperature ever observed, -68 deg. C., (-90.4 deg F.), was recorded on January 15th, 1885, at Werchojansk in Eastern Siberia, a little north of the Arctic Circle.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
FRANK RICHARDS, - - Managing Editor
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W. C. LAROS, - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. JULY, 1910. No. 7

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CORE-DRILL ECONOMICS

In considering schemes and operations having to do with the material constituents of the earth's integument, perhaps nothing can be more suggestive and helpful to have at hand than an 8-inch terrestrial globe. It offers special facilities for us if we wish to do our thinking to scale, which is really more necessary than drawing or working to scale, as correct thinking must precede successful and profitable accomplishment.

On this 8-inch globe, 1 inch in any direction will represent very closely a thousand miles; and one-thousandth of an inch, or, say, one layer of the thinnest tissue paper, therefore, will represent one mile, covering practically our utmost penetration and knowledge of the earth's crust. The deepest coal mine in the world is not more than three-quarters of a mile down, and none in the United States has reached half through our sheet of tissue paper. This may help us to realize how infinitesimal are our most boasted operations, in comparison with the bulk of the body whose skin we have so imperfectly scratched, and it suggests how saving we should be of our efforts, that none of our time or strength should be wasted.

The most valuable of all devices as yet in sight for the revelation of Nature's cunningly hidden treasures is undoubtedly the core drill. It is of unspeakable value to the miner and prospector in locating veins and revealing deposits previously unknown. Not the least of its value lies in the determination of where not to sink shafts or run tunnels, thus saving unnecessary labour.

An obvious suggestion in connection with the work of the core drill is that its own results should be systematically recorded and kept available for future consultation, so that other prospectors in the same neighborhood or investigators of the same strata should have the benefit of the preceding labour without being obliged to do the work over again. It would seem to be an open question whether the records of the core drill, however and by whom made, should be regarded as the exclusive property of those with whom they have been originated, or whether they are not subject to the general claim of the mass of humanity which is beginning to crowd the earth and must live by what can be drawn out of it.

The systematic arrangement and preservation of such core samples or records would seem to be one important service which could, and should, be rendered by the new Bureau of Mines. We should never be satisfied for this important bureau to be merely an accumulator of records after the event. It should be able also to indicate some, at least, of the opportunities of the future, and thus promote more gainful practice in working beneath the surface of the earth, just as the Department of Agriculture is doing much to make farms more remunerative.

Immense sums have been and are being most commendably spent by the government in mapping the surface of the land, and, to some extent, in determining its elevations and depressions. Expenditures for this purpose must not only be regarded as legitimate, but would be insisted on by popular opinion, if any attempt were made to curtail them. Why should we not also advocate the mapping of the earth below the surface within practically accessible depths? We can only imagine what would be the result if the Bureau of Mines had a thousand core drills continually at work, intelligently located and directed, and could thus be able to furnish accurate tabulated information for the benefit of future development and work.

For exploration and official record service, as here suggested, the core drill might begin where the air driven rock drill is now compelled to leave off, at the lowest depths of the deepest mines. Where temperature and other conditions bar the further descent of men for active work the core drill might then begin and double the distance. If the findings should prove promising there can be little doubt that ways of reaching downward would develop and the world would be the richer.

GAS POWER TRANSMISSON

In pumping oil through pipes it is usual to pump it a certain distance and then use a relay pump for the next stage. In handling gas this is not as efficient a method as to compress the gas at the first station to a maximum density. The amount of gas that can be passed through a line between given points depends upon the difference between the squares of the initial and discharge pressures. It is much more economical to pump the gas with one high-stage compression at the initial end than to relay it with several low-stage compressions. The practical result of this experience is that the compressor plants are placed in locations convenient to the wells, and the gas is forced through the transporting lines to the immediate vicinity of consumption, where the pressure in the city distributing lines is regulated by equalizing valves.

The principal cost of transporting gas—or, as it really is, power—through pipe lines is evidently the interest on the capital required, depreciation and maintenance. That there are many instances where this is much lower than rail or water haulage of an equal amount of power is unquestionable. Whether it is less than the electric methods is a mere guess, as the companies which own the pipe lines have been very secretive about costs and maintenance charges. That it has been, and is, extremely profitable, is proved by the earnings of the companies which supply many cities in the territory served by the Pittsburg and West Virginia district.

Conservative investors have refrained from advocating the securities of these gas companies, not because the efficiency of the method of transporting was questioned, but because they were skeptical as to the continued supply of the natural fuel. As early as 1888 an English engineer, in a monograph on the then infant natural gas industry, called attention to the fact that, should the natural gas fail, the companies could erect coke ovens and send the artificial gas through their lines in place of the natural gas. It is immaterial whether the coke or the natural gas be considered the by-product of the modern improved oven, because either would pay all expenses and leave the other as a net clear profit.

Modern mechanical engineering is responsible for the fact that cities such as Cincinnati and Cleveland, located several hundred miles from the gas fields, are able to enjoy the advantages of a convenient low-priced and abundant gas fuel for commercial and domestic uses. The two principal elements which should be mentioned in this connection are the economical and efficient gas compressors and riveted pipe lines which can be constructed at a reasonable rate, but which will stand high pressures without undue leakage.

It is reasonable to predict that plants will be constructed in the future to handle artificial gas alone, and when this is done a part of the now tremendous cost of handling and delivering coal in large cities will be eliminated, and a large economic saving will result—*Cassier's Magazine.*

A BUREAU OF MINES

The following comprises all the essential provisions of the bill recently passed and signed creating a Bureau of Mines in the Department of the Interior:

The director of the bureau shall be thoroughly equipped for the duties of said office by technical education and experience and shall be appointed by the President, by and with the advice of the senate, and shall receive a salary of $6,000 per annum; and there shall also be in the said bureau experts and other employes that may from time to time be authorized by congress.

Sec. 2. It shall be the province and duty of said bureau and its director, under the direction of the secretary of said department, to make diligent investigation of the methods of mining, especially in relation to the safety of miners, and the appliances best adapted to prevent accidents, the possible improvement of conditions under which mining operations are carried on, the treatment of ores and other mineral substances, the use of explosives and electricity, the prevention of accidents and other inquiries and technologic investigations pertinent to said industries, and from time to time make such public reports of the work, investigations and information obtained as the secretary of said department may direct, with the recommendations of such bureau.

Sec. 3. The secretary of the interior shall provide the said bureau with furnished offices within the city of Washington, with such books, records, stationery and appliances, and such assistants, clerks, stenographers, typewriters and other employes as may be necessary for the proper discharge of the duties imposed by this act upon such bureau, fixing the compensation of such clerks and employes within appropriations made for that purpose.

Sec. 4. The secretary of the interior is hereby authorized to transfer to the bureau of mines from the United States geological survey the supervision of the investigations of structrual materials and the analyzing and testing of coals, lignites and other mineral fuel substances and the investigation as to the causes of mine explosions; and the appropriations made for such investigations may be expended under the supervision of the director of mines, in manner as if the same were so directed in the appropriations acts; and such investigations shall hereafter be within the province of the bureau of mines, and shall cease and determine under the organization of the United States geological survey.

Sec. 5. Nothing in this act shall be construed as in any way granting to any officer or employe of the bureau of mines any right or authority in connection with the inspection or supervision of mines or metallurgical plants in any state of territory.

NEW BOOK

Self-Taught Mechanical Drawing and Elementary Machine Design, by F. L. Sylvester, M. E., with additions by Erik Oberg, Associate Editor of Machinery, New York, Norman W. Henley Co., 330 pages, 7x5 inch, 315 cuts. Price $2.00.

This is an excellent practical treatise on the subjects indicated, comprising the principles of geometric and mechanical drawing, workshop mathematics, mechanics, strength of materials and the design and calculation of machine details. It is clearly written, comprehensive, carefully arranged and well adapted to the use of the young man who must study without a teacher.

TIME AND COST OF ROCK DRILLING IN ALASKA

The following figures are from the annual report of Mr. R. A. Kinzie, superintendent of the Ready Bullion Mine, Douglas Island, to the Alaska United Gold Mining Company:

Stoping, 33.06 ft. drilled and 46.36 tons broken per machine-drill shift; development, 40.42 ft. and 12.07 tons; sinking, 45.08 ft. and 15.24 tons. The cost of explosives in stoping averaged about $1.95 per drill per shift; in sinking, $2.70; and in drifting, from $1.90 to $2.88. The average cost of supplies, power, repairs, etc., was $5.65 per drill per shift. On the 700-Foot Claim mine of the same company the average number of feet drilled per machine per shift in stoping was 24.99, breaking 36.94 tons of rock; and in development, 31.88 ft. breaking 7.89 tons. The cost for explosives per drill per shift varied from

$1.82 to $2.28 in stoping, and from $1.85 to $3 in development. On this mine, the cost of supplies, power, repairs, etc., was $4.68 per drill per shift.

CHARGING AIR VESSELS OF MINE PUMPS

When some mine pumps delivering 1,200 gallons per minute against a head of 1,000 ft. were first started considerable difficulty was experienced in obtaining quickly a sufficient air cushion in the air vessel of the discharge to prevent an annoying hammer. A remedy was found in an air-charging device. A length of extra heavy pipe, with blind flanges on each end, was placed alongside the pump. Connections were made from the air vessel to the pipe, and also from the column pipe and the air line in the mine. A drain was placed in the lower end of the pipe. To use this device, all connections are at first closed, except that to the air line, which charges the pipe with air at a pressure of 90 to 100 lbs. The air connection is then closed, and that to the water column opened. This allows the pressure of the water in the column to compress the air. The column connection is next closed, and that to the air vessel opened. After charging the air vessel the pipe is drained of water, and the operation can then be repeated.—*The Engineer,* London.

COMPARATIVE COST OF COAL AND OIL FUEL FOR RAILROADS

The following figures relating to the relative cost and efficiency of coal and of oil are current in California:

Two and one-half barrels of oil are the equal of one ton of coal in thermal units. In other words, the same amount of heat can be obtained from 2½ barrels of oil as can be obtained from one ton of coal. But the difference in price is very great. Coal, producing the same amount of heat per ton as 2½ barrels of oil costs in California anywhere from $6 to $8 per ton wholesale. Two and one-half barrels of oil, figured at the market delivery price of $1 per barrel, costs $2.50—a saving of from $3.50 to $5.50 on every ton of coal displaced by oil. Under the circumstances it would be impossible that any other fuel could be obtained which could displace oil, and such being the case, there is a guaranteed consumption from every railroad on the coast as long as the oil fields hold out.

RESINITE

A new maerial to which the above name has been given has made its appearance in Germany. It is produced in a variety of modifications by the union of formaldehyde and carbolic acid in connection with certain metallic salts. One special variety is used chiefly with porous materials, such as wood, paper, pasteboard, etc., and renders them hard and impermeable. Thus ordinary pine wood when thoroughly impregnated, becomes so hard that it rapidly dulls a planer. In another form it can be poured as a liquid into molds. After coagulation it is transparent, with ruby tints, infusible, and unaffected by ordinary chemical reagents. It is well adapted for making ornaments, such as hat-pin heads, imitation jewelry, and for most purposes where enamel or enamel varnish are employed. For doorplates, street numbers, signs, etc., it seems capable of rendering excellent service, being entirely unaffected by atmospheric action. A third modification is liquid, but upon the addition of a mineral acid, it solidifies in a few minutes to an elastic, homogeneous substance, which can be easily cut, turned, polished, etc. In this form resinite can replace for a multitude of purposes, horn, celluloid, vegetable ivory, and similar substances. Buttons, knife handles, mosaic designs, are some of the many objects made with this modification. When competing with celluloid, it possesses the great advantage of being noncombustible.

USES OF COMMERCIAL OXYGEN

As oxygen is now produced on a commercial scale from liquid air, the future profitable uses of it are being exploited. M. Georges Claude, of Paris, shows that oxygen can increase by 40 per cent. the yield of the reactions which serve as the base of the fixation of nitrogen by the electric arc, and it can improve the manufacture of ozone by nearly 300 per cent. A Belgium firm has ordered from the Paris Liquid Air Company three sets of apparatus for producing oxygen, each having a yield of 200 cubic yards of oxygen per hour, to be used for experiments in blast furnace working. It is estimated that unit apparatus can be produced having a capacity of 1,000 cubic feet of gas per hour, working

a pressure of 10 atmospheres and furnish-
g 1.5 cubic yards per horse power hour,
hich would bring the price per cubic yard
low as 0.5 cent. A factory occupying not
ore than 60 by 100 feet could contain every-
ing needed for producing 50,000,000 cubic
rds of oxygen per annum, with about 15
nployees.

LECTRIC FLASHES AND COAL DUST IGNITION

A paper by Dr. Thornton and Mr. Bowden
"The Ignition of Coal Dust by Electric
lashes" was recently read at Newcastle. Ex-
riments have shown that dry coal dust in
lk is a non-conductor of electricity, but
hen made into a paste with water it is liable
cause a short-circuiting flash if placed be-
veen electrodes. If a flash is produced—as
opening a switch—in a cloud of dust an
xplosion is produced. The character of the
st cloud and the strength and voltage of the
rrent broken affects the readiness with which
e dust is ignited, and at medium voltages
rect current appears to be more dangerous
an alternating. In view of the conclusive
xperiments on coal dust explosions produced
the discharge of a cannon, as carried out
Altofts, the result obtained by Messrs.
hornton and Bowden were to be expected.

TEMPERATURE TROUBLES

There is no temperature unit corresponding
a foot rule or a meter stick which can be
pplied successively to measure an unknown
mperature as we would measure the height
f a room. Two temperatures of 1 degree
nnot be combined in any way to give a tem-
erature of 2 degrees. Temperature measure-
ent is, therefore, wholly a matter of arbi-
ary definition, of selecting some convenient
henomenon like the expansion of gas, which
aries continuously and uniformly (as nearly
possible) with temperature changes, of
roviding convenient arbitrary units of sub-
ivision, and then of observing its behavior
nder the same conditions which surround the
nknown body whose temperature is desired.
he expansion of hydrogen has been estab-
shed by international agreement as our fund-
mental measure of temperature. The gas
hermometer is, therefore, now the standard
hermometer in terms of which all temper-
tures are expressed.

NOTES

Rio Tinto, undoubtedly the greatest single copper mine now producing, worked last year on ores having an average copper content of only 2.349 per cent. A little over a million and three quarters tons of ore were produced.

At the Alaska-Mexican mine in 1909, the machine drills working on stoping averaged 39.95 tons per drill per shift, drilling 27.16 ft. of hole; on development, they averaged 12.41 tons, drilling 34.72 ft.; and on cutting out, 15.13 tons, with 30.69 feet.

At Ugine, Belgium, in connection with Girod electric steel furnaces, there is a large forge containing nine hammers operated by compressed air. The Ram of the heaviest of these hammers weights 10,000 pounds, while the weights of the others range from 2,000 to 200 pounds.

The Atlantic Transport Liner, Minnehaha, which struck and stuck on the much dreaded rocks at the western end of the Scilly Islands, and was given up as a total loss, finally got the laugh on the maritime world by hauling off and reaching a port of safety under her own steam.

The Florida farmer receives $2.25 for a bushel of green beans, a railway gets 50 cents for the 800 mile haul to New York and the consumer pays $6.40 for this same bushel of beans. There is 35 per cent. for the grower, 8 per cent. for the carrier and 57 per cent. for the dealer.

The General Electric Company in 1909 paid for patents and patent litigation $904,207, which sum is not counted as an asset, but is charged over to profit and loss. All the company's valuable patents, franchises, and good wills stand in the balance sheet at a nominal valuation of one dollar.

The Assopus viaduct, or bridge, which forms part of a new line extending by way of Demirli to the Turkish frontier, is a structure of graceful design and picturesquely situated, 600 feet long, spanning a gorge 330 feet deep, connecting tunnels on each side. The bridge has a grade of two per cent. with a curve of four degrees.

When one solid body glides over the surface of another, the coefficient of friction diminishes as the velocity increases, and nearly vanishes when the velocity attains a certain critical value. This diminution of friction is due to the air which partially separates the two bodies at low relative velocities and separates them completely at the critical and all higher velocities.

The dangers of atmospheric electricity in aerial navigation are attracting considerable attention. While an ordinary balloon without metal parts is not exposed to any danger as long as it floats in the air, the modern dirigibles are provided with much framework made of conducting metals. Even a balloon, however, may be charged with electricity and a spark produced when contact with ground is made, thus setting fire to the gas.

The article upon "Factory Humidifiers" in our June issue, the information coming from an English source, has brought to our attention the fact, which we should have known before, that humidifiers of the type described are produced in a much improved form and manufactured in large numbers by the American Moistening Company, 120 Franklin street, Boston, and are already in use in some 900 American factories.

The Dodson automatic shot firing machine, which does away entirely with personal exposure in this responsible and dangerous operation, is beginning to attract attention. It is the invention of Mr. C. I. Dodson, of Pittsburg, Kansas, who has had a wide experience as a shot firer. It has been exhibited to many miners and operators who pronounce it just the thing for the purpose, saving life, time and expense, without any objectionable features.

According to experiments on the reception of radio-telegraphic signals when transmitting with a spark gap in compressed air, as compared with signals received when an ordinary spark gap was used, there appears to be no advantage in using compressed air for this purpose. While the dielectric strength of the air is enormously increased, so also is the resistance to the oscillatory spark, both appearing to increase in about the same ratio.

Compressed air for signalling from the bottom of shafts to the hoisting engine room at the surface is used at the Moodna pressure tunnel of the Catskill Aqueduct. An air pipe extends up the shaft and into a cylinder alongside of the hoist runner; in this cylinder is a metal piston or plunger which strikes a gong when pressure is applied.

At Windsor, Ontario, natural gas, piped forty miles, has been turned into the mains heretofore used for the local manufactured gas. In use only the gas for lighting is purified, and this is done by individual purifiers on the premises of each consumer. The gas will be used by the people generally for fuel, but for illuminating many prefer electricity. The price of the gas is 25 cents in the winter and 30 cents in the summer per 1,000 feet.

On March 29, 1910, the Penberthy Injector Company numbered its six hundred thousandth Penberthy Automatic Injector, by far the highest number of injectors manufactured by any one concern in the world, and the combined capacity of which is so great as to be almost incomprehensible to the average person. A computation has been made of the combined water capacity of this multitude of injectors and it is found to actually equal one-third of the flow of Niagara.

The United States Navy Department has decided upon removing from the active list fifty million dollars' worth (at least that is what they cost, and not very long ago) of war ships, comprising 11 protected cruisers, 3 unprotected crusiers, 10 monitors and a group of smaller craft. These are "no longer to be regarded as fighting ships." They are said to be "rusty, costly, and ineffective, and if they were sent against an enemy they would be of no practical use."

Compressed acetylene is prepared by using steel cylinders filled with a porous mixture of infusorial earth, special wood charcoal and a suitable binder, and forcing into these cylinders the acetone and then the acetylene. At ordinary temperature and pressure the acetone dissolves 24 volumes of acetylene, which is increased about 12 times at 12 atmospheres. The cylinders have capacities of about ⅛, ½ and one cubic foot, and contain respectively 12, 50 and 100 cubic feet of acetylene measured at atmospheric pressure.

The effect of high temperature and humidity on men working underground should be carefully studied by all mine superintendents. At a high temperature in saturated air, it becomes difficult for miners to remain, even without working. A temperature of 90 deg. in saturated air is a practical limit above which no work can be done. On the other hand, it is a fact that if the air is dry, much higher temperatures can be borne with comfort. In many coal mines, where the air is dry and in motion, men can work in a temperature ranging from 100 to 120 degrees.

Contractors are being asked to bid for the construction of five drainage canals, aggregating about 235 miles, for the lowering of the level of Lake Okeechobee, Florida. The contract for this mammoth enterprise will be let in a few weeks. The construction of these canals will require the excavation of approximately 18,000,000 cubic yards of earth and 6,000,000 cubic yards of rock. The five canals will be known as the North New River, the South New River, the Miami branch, the Hillsborough canal and the Gulf Coast canal. These canals will vary in width from 50 to 70 feet and range in depth from 8 to 12 feet.

The new ore and coal docks at Rio de Janeiro, which will handle 90 per cent. of the Brazilian business in these commodities, are to be constructed and equipped by an American. This contract was awarded by a commission after an exhaustive study of the methods of both Europe and America. A Brazilian engineer has been quietly conducting this investigation during the past year, and he is now on his way home, carrying with him the full plans and details of new quays and equipment. The amount to be spent in equipping this piece of work is about $15,000,000. The fact that in the expenditure of this vast sum no competition was asked for is regarded as a distinct triumph for American methods and equipment.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MAY 3.

956,535. PNEUMATIC CLEANER. Augustus Lotz, San Francisco, Cal.

956,627. ART OF TUNNEL CONSTRUCTION. John P. Conkling, New York, N. Y.

956,648. DEVICE FOR AERIAL NAVIGATION. Henry C. Schanze, Sr., Camden, N. J.

956,784. PORTABLE VACUUM-PUMP. Joseph H. Templin, Philadelphia, Pa.

956,789. DISCHARGE-VALVE FOR ELASTIC-FLUID COMPRESSORS. James Allan, Omaha, Nebr.

956,839. METHOD OF PUMPING AIR OR OTHER FLUID. Theodore Wiedemann and Joseph H. Templin, Philadelphia, Pa.

2. The method of producing and maintaining a variable vacuum, which consists in exhausting air from the vacuum space by producing alternately higher and lower pressure within a given space, separating the impurities from the air in the vacuum space, and in limiting the lowest pressure in said given space by the amount of space which it contains.

956,862. VACUUM DUST-REMOVER. John G. Meyer, Portland, Oreg.

957,019. TRACK-SANDER. John H. Watters, Augusta, Ga.

957,084. AIR-COMPRESSOR. Alfred T. Newell, Birmingham, Ala.

In a non-rotatable air-compressor, the combination of inner and outer circular concentric tracks, an axle pivoted at one end at the center of said tracks and extending radially over the same, a roller carried by said axle and located on the inner track, pumps under said track, having operating means actuated by the passage of the roller thereover, and a motor mounted on the outer track and connected to the outer end of the axle.

957,126. PNEUMATIC COTTON-SEED CONVEYER. Benjamin W. Tilley and Benjamin F. Tilley, Bearcreek, La.

957,129. COMPRESSOR. Governor D. Warren, Denver, Colo.

MAY 10.

957,194. AUTOMATIC PNEUMATIC CHUCK. Nathan M. Doen. Lynn, Mass.

957,197. HUMIDIFIER. John W. Fries. Winston Salem. N. C.

957,205. AIRSHIP. Rudolph Gendts, New York, N. Y.

957,227. ELECTROPNEUMATIC AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

957,269. VACUUM-TRAP. Leslie P. Strong, Cleveland, Ohio.

957,304. PNEUMATIC PRESSURE APPARATUS FOR WATER-TANKS. Ralph B. Carter, Haworth, N. J.

957,339. FLUID-PRESSURE MOTOR. Harris B. Holt, Pittsburg, Pa.

957,385. AIR-HOSE COUPLING. Eugene W. Shaw, Weir, Kans.

957,430. HUMIDIFIER. Edward Maxwell, Montreal, Quebec, Canada.

957,558. VACUUM-FILTER. Martin E. Hiltner, Deadwood, S. D.

957,607. FAN-BLOWER. Samuel Higgins, Milwaukee, Wis.

957,656. MECHANISM FOR ELEVATING LIQUIDS. Martin J. Christensen. Chicago, Ill.

957,685-6. CONDENSING FLUID SUBSTANCES. Albert G. Kalb, Chicago, Ill.

957,708. IMPACT-TOOL. John J. Padbury, Philadelphia, Pa.

957,751. PNEUMATIC MOTOR. Thomas Dan-

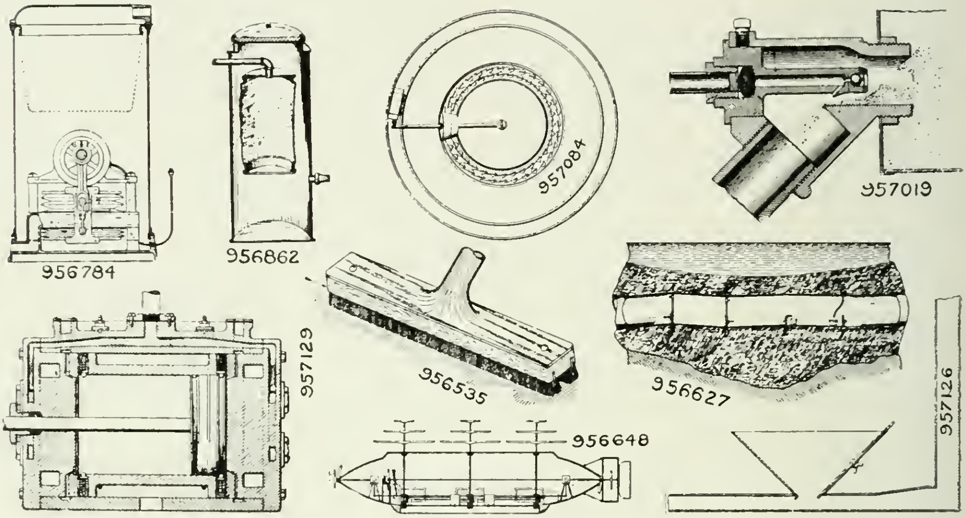
QUARD, New York, N. Y.

957,752. REGULATOR FOR PNEUMATIC MOTORS. Thomas Danquard, New York, N. Y.

957,804. VACUUM-SUPPORTING DEVICE. Florence P. Schroeder, Berkeley, Cal.

957,849-50. DESICCATING FLUID SUBSTANCES. Albert G. Kalb, Chicago, Ill.

1. In apparatus for desiccating fluid substances means for forming a current of air and maintaining said air in motion by constantly renewing the same, means for spraying the air with the fluid being treated, means for collecting part of the desiccated material, means for spraying the air and the residue of the particles carried by it, and means for forcing said sprayed air through the fluid being treated substantially as described.



Pneumatic Patents, May 3.

MAY 17.

957,957. MINING-MACHINE. John C. Hirst, Reynoldsville, Pa.

958,133. STERILIZER AND DRIER. Aage Jensen, Eureka, Cal.

958,137. PNEUMATIC STRAW-STACKER. Peter T. Kirkpatrick, Battle Creek, Mich.

958,184. PROCESS FOR QUENCHING COKE. Eduard Schulte, New York, N. Y.

1. The process of cooling combustible substances, which consists in closing them within an air-tight casing containing a cooling medium and inert gases, and circulating said gases in a continuous circuit in contact with the combustible substances and the cooling medium.

958,240. CARRIER FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Merton L. Emerson, Braintree, Mass.

958,345. VACUUM-PUMP. John T. Wilkin, Connersville, Ind.

958,393. ENGINEER'S VALVE FOR PNEUMATIC SANDERS. John H. Hanlon, Somerville, Mass.

958,428. METHOD FOR BURNING GASES. Henry E. Parson, New York, N. Y.

958,429. FURNACE FOR BURNING BLAST-FURNACE GASES. Henry E. Parson, New York, N. Y.

958,460. AIRSHIP. Louis Arnheiter, Jersey City, N. J.

958,536. SPRAYING ATTACHMENT. Charles H. Rath, Philadelphia, Pa.

958,555. HUMIDIFIER. Robert P. Smith, Winchester, Mass.

958,669. PNEUMATIC HAMMER - SUPPORT. Harry Neville, Los Angeles, Cal.

958,697. ATOMIZER. Frank C. Dorment, Detroit, Mich.

958,705. BLOWING-ENGINE OR COMPRESSOR. George Mesta, Pittsburg, Pa.

MAY 24.

958,747. FLYING-MACHINE. John Koskine, Detroit, Mich.

958,769-70. PROCESS OR METHOD OF PURIFYING OR CLARIFYING WATER. William K. Richardson, Leavenworth, Kans.

2. The process or method of purifying and clarifying water, which consists in subjecting water to the action of centrifugal force in the presence of air under pressure, aerating and discharging the pure water by pneumatic pressure, and separately discharging the precipitate by pneumatic pressure, substantially as described.

958,814. DRILLING-MACHINE. Nils D. Levin, Chicago, Ill.

958,867. CAP FOR VALVE-STEMS FOR PNEUMATIC TIRES. George F. Foss, Los Angeles, Cal.

958,928. AUTOMATIC JACK FOR ENGINE-BOILERS. Charles Kent, Pevensey, Ontario, Canada.

958,952. TUNNELING-MACHINE. George R. Bennett, Denver, Colo.

959,010. AIR-BRAKE. Thomas J. Henretta, Roanoke, Va.

959,022. REGULATING-VALVE FOR AIR-BRAKE SYSTEMS. Joseph C. Luna, Oakland, Cal.

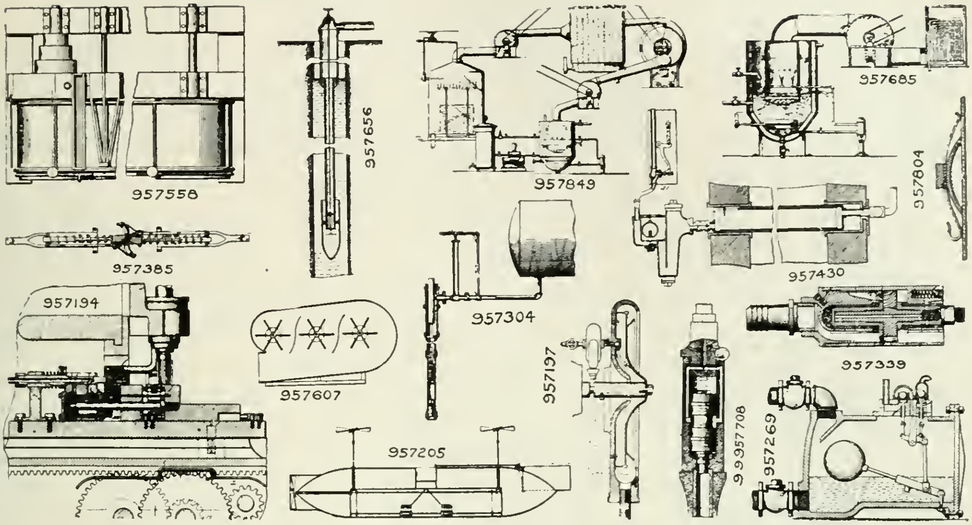
959,049. POSITIVE-PRESSURE BLOWER. Francis P. Boland, Providence, R. I.

959,073. RELAY AIR-VALVE. Harvey J. Richardson, Chicago, Ill.

959,114. FLUID-PRESSURE BRAKE. John Willis Cloud, London, England.

959,122. AIR-BRAKE SIGNALING DEVICE. Frank Hutchinson Dukesmith, Meadville, Pa.

959,123-4. AIR-BRAKE-TESTING APPARATUS. Frank Hutchinson Dukesmith, Meadville, Pa.



Pneumatic Patents, May 10.

959,128. FLUID-PRESSURE BRAKE. Fred B. Farmer, St. Paul, Minn., and Walter V. Turner, Wilkinsburg, Pa.

959,209. AIR - BRAKE - TESTING SYSTEM. Frank H. Dukesmith, Meadville, Pa.

959,219. COMPRESSED-AIR LOCOMOTIVE. Charles G. Herman, Philadelphia, Pa.

959,266. AERIAL SHIP. Frederick W. Schroeder, Kennington, London, England.

959,363-4. OIL-BURNER. Arthur H. Light, Los Angeles, Cal.

959,417. FLUID-OPERATED CONTROLLING MECHANISM. John W. Anderson, Sisson, Cal.

MAY 31.

959,471. GOVERNOR FOR STEAM OR ELASTIC-FLUID ENGINES. Charles W. Dake, Grand Rapids, Mich.

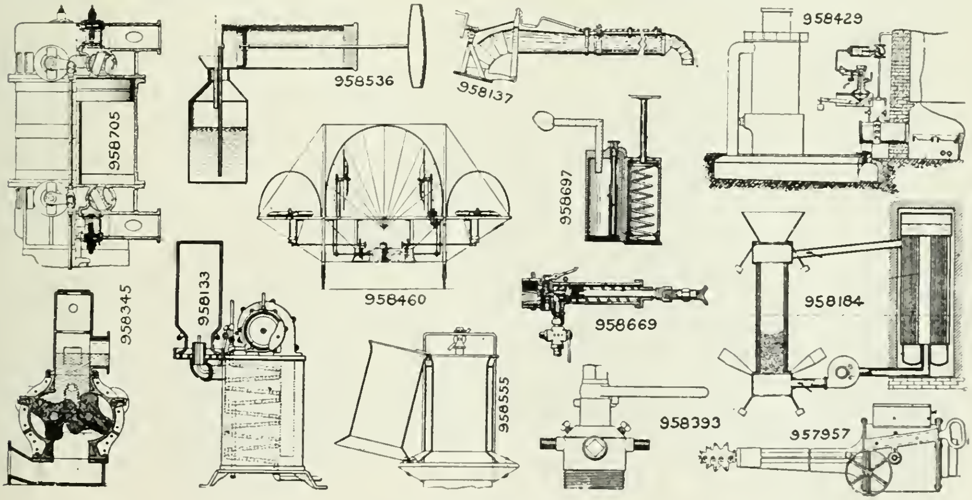
959,526. WRECKING APPARATUS. Jens M. W. Hassing and James V. Fitzsimmons, San Francisco, Cal.

1. In a wrecking apparatus, an elongated flexible bag, reinforcing bands thereon, an opening for admitting air thereto, an open sided link connected to said bag and guide rods adapted to be engaged by said link.

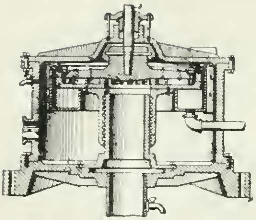
959,530. TOOL-RETAINER FOR AIR, ELECTRIC, OR MECHANICALLY-DRIVEN IMPLEMENTS. Meier G. Hilpert, Pittsburg, Pa.

959,547. FLUID - OPERATED APPARATUS. Eugene Ketterer, Essen-on-the-Ruhr, Germany.

959,593. GAS AND AIR MIXER FOR BURNERS. Gus A. Peterson and Jesse L. Lackett, Clarksburg, W. Va.



Pneumatic Patents, May 17.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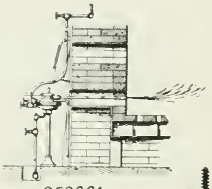
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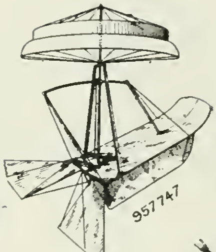
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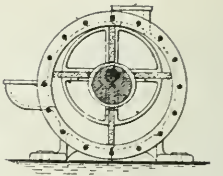
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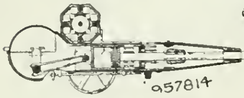
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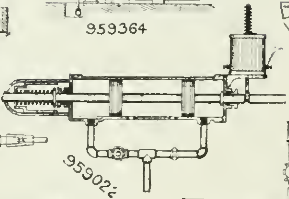
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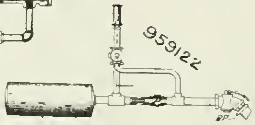
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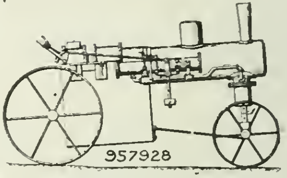
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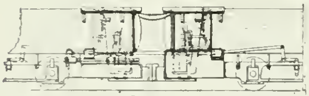
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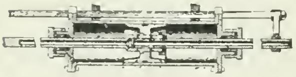
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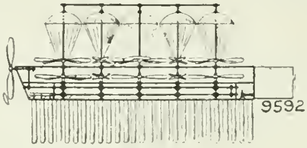
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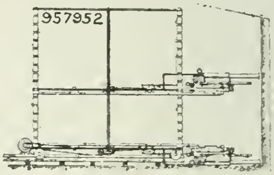
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Pneumatic Patents, May 24.

959,596. TRACK-SANDER. William Alexander Pitt, Montreal, Quebec, Canada.

959,642. PNEUMATIC TRANSMISSION SYSTEM. Joseph J. Stoetzel, Chicago, Ill.

959,694. APPARATUS FOR FORCING LIQUID OUT OF RESERVOIRS. Leonard Barbas, Paris, France.

959,729. VACUUM-CLEANER. Charles B. Foster and Wilmot W. Glidden, Oak Park, Ill.

959,798-9. ENGINEER'S VALVE. William A. Pendry, Detroit, Mich.

959,800-01. TRIPLE VALVE. William A. Pendry, Detroit, Mich.

959,802. ENGINEER'S VALVE. William A. Pendry, Detroit, Mich.

959,889. AIR-GUN. Elbert Hamilton Searle, Springfield, Mass.

959,894. TIRE-PUMP. William S. Stapley, Bridgeport, Conn.

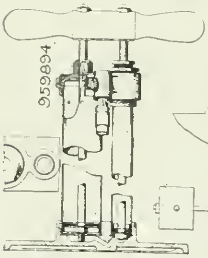
959,957. PROTECTOR FOR PNEUMATIC TIRES. Robert J. Morrison, St. Louis, Mo.

960,023. AIR-LIFT. Walter A. Knight, Pleasant Ridge, Ohio.

960,033. AUTOMATIC FLUID-REGULATOR. James J. McDonald, Cleveland, Ohio.

960,084. AUXILIARY AIR-VALVE FOR CHARGE-FORMING DEVICES. Jacob H. Friedenwald, Baltimore, Md.

960,233. PROCESS OF COMPRESSING AIR, GAS, OR OTHER GASEOUS FLUIDS. Eu-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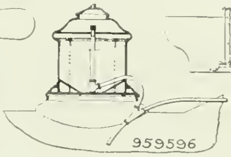
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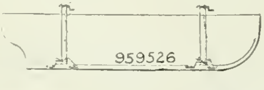
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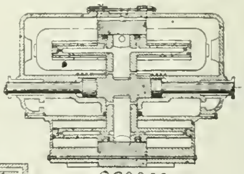
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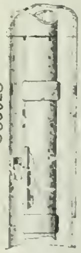
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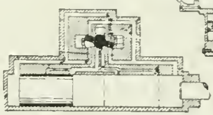
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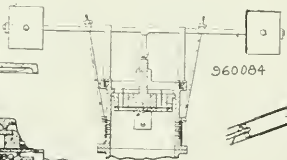
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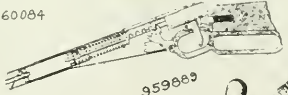
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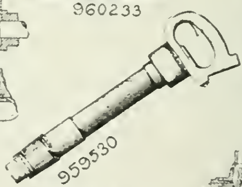
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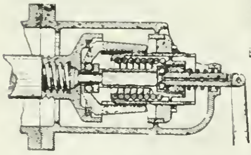
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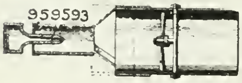
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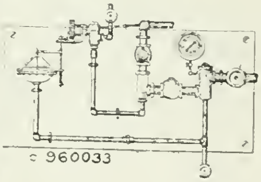
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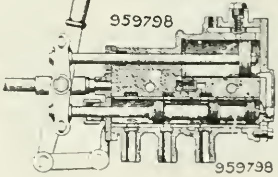
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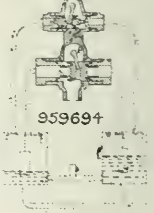
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Pneumatic Patents, May 31.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV AUGUST, 1910 No. 8

FLOATING AND REPAIRING THE NERO

Although the initial occurrence and the details of some of the later operations have been noted in the daily papers, it is only lately that it has become possible to tell completely the story of the salvage and repair of the valuable United States collier "Nero," which was stranded upon the rocks of Brenton's Reef, near Newport, R. I., about a year ago; and this has now been graphically done in *Reactions,* the attractive quarterly issued by the Goldschmidt Thermit Company, under the permission of the Navy Department, the transactions having been under governmental supervision throughout. What follows is an abstract of the article referred to.

When the Nero was stranded attempts were made on the same day by several naval vessels in the vicinity to float her, but without success. The next day the services of Mr. John Arbuckle, who was at that time engaged in the salvage of the U. S. S. "Yankee," at Buzzards Bay, were secured.

Mr. Arbuckle's men commenced operations on July 3 and the ship was found to be injured quite severely, leaking in nearly all the compartments except the engine and boiler rooms. Powerful pumps were installed to rid the vessel of water, and on July 6 and 7 three attempts were made to float her, but without success, although at one time nine tugs were employed.

Saving the "Nero" by this means having

U. S. S. "NERO" ON THE ROCKS.

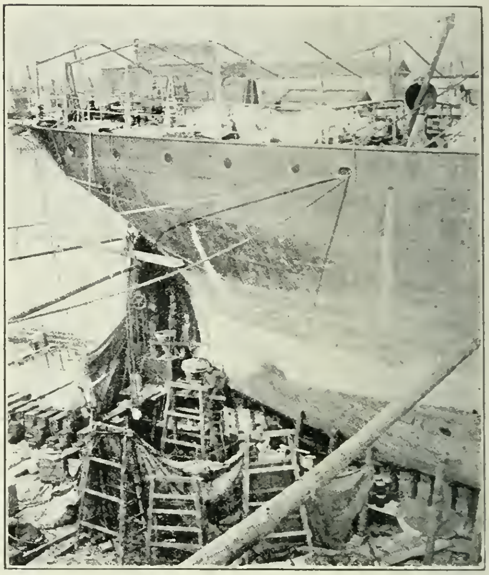
failed, it was decided that the only way of floating the vessel would be to use the compressed-air method which had been successful in other cases, notably the "Mt. Temple," "Bavarian" and "Yankee." The work of closing up the hatchways of the "Nero" by means of steel plates was at once undertaken and an air compressing plant was installed. The now familiar mode of operation is as follows: All openings in the upper parts of the various holds are hermetically sealed, after which compressed air is pumped in and a sufficient pressure is created to drive the water out of the hold through the rents in the bottom. Then workmen, who enter the hold by means of air locks, effect such temporary repairs as are possible.

In the case of the "Nero" the work was nearly completed when a storm caused the ship to shift and in her new position on the rocks a large hole developed in the engine and boiler compartment, which had been dry up to this time. This necessitated the application of compressed air to that compartment also, and the engine and boiler rooms were accordingly made air tight, a task which was completed in less than a week, and which was really a remarkable performance considering the difficulties encountered. An idea of the work involved may be gained from the fact that the ship's engine had to be partially dismantled while the plating put over the fire room made it necessary to cut away the lower part of the ship's smokestack.

On August 1 the work of installing plating, etc., was completed and it was then possible to expel the water from all parts of the ship by pumping in compressed air. On the next day, everything being ready, the tugs made another effort to dislodge the ship and at this attempt, the water being entirely displaced by compressed air, sufficient buoyancy was gained to float the ship, and she was pulled from her position without much difficulty. She was at once taken in tow and the trip to Newport harbor commenced. During this voyage, she remained afloat only because of the air pressure maintained inside of her which prevented water from entering through the many holes in her bottom.

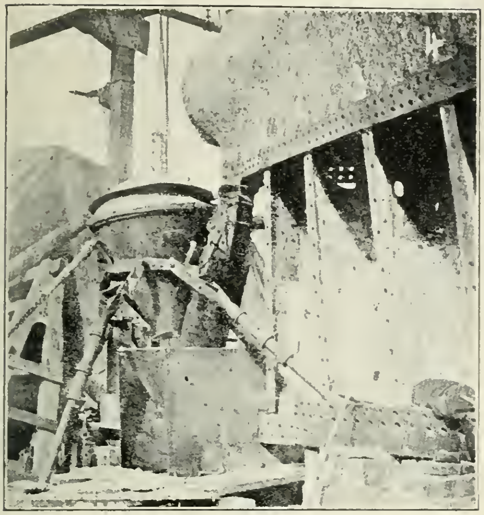
After she was successfully berthed at a dock in the harbor, arrangements were completed to make her sufficiently seaworthy to stand the trip to the Brooklyn Navy Yard. Her hull had been very badly damaged during the stay of a month or more on the rocks, and the many rents in it had to be temporary patched. It was also found that the injuries caused the ship to be structurally weak and considerable work was done in the way of strengthening and reinforcing bulkheads, tank tops, etc.

In December the ship was prepared for towage to New York, although during her stay at Newport no active work was done on her for nearly three months. The condition of the ship was such that she would not remain afloat at all without the aid of the compressed-air plant. The voyage to New York, made December 21-22, was unique on this account. As the engine and boiler compartments were entirely out of commission, being under air pressure, the trip was made with the aid of powerful tugs. During this trip, which lasted twenty-six hours, skilled compressed-air workmen were constantly at work inside of all the compartments to see that nothing gave way.



IN DRYDOCK—PREPARATIONS FOR TWO WELDS.

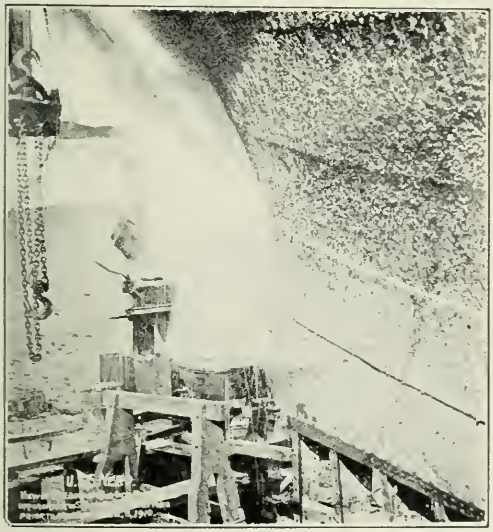
When the Brooklyn Navy Yard was reached the ship was at once floated into drydock, but as a result of her sojourn on the rocks the contour of her underbody was decidedly irregular. The keel blocks were arranged in conformity with the ship's docking plan, but there were so many rents and dents in the plating that had the ship been let down from the



FOR WELDING BREAK IN SHOE.

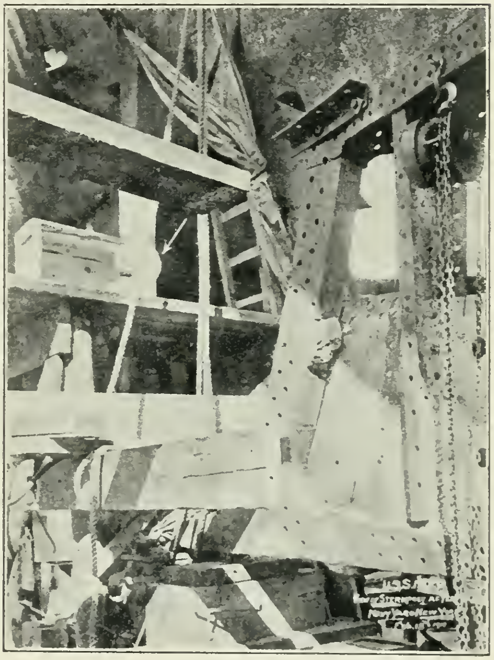
blocks as they were her weight would have been too unevenly distributed. The water in the dock, therefore, was pumped down only a few feet and then divers were set to work to build up the blocks and shores under the uneven places so as to properly support the vessel. This work occupied about two days before the remainder of the water could be pumped out.

Until the vessel reached her final resting place on the blocks she had been kept afloat in the dock by the ever-useful compressed air, which was only released when the vessel was high and dry on the ways.



WELDING RUDDERPOST AND ONE BREAK IN STERNPOST.

It was then possible to obtain an idea of the extent of the injuries which the ship had suffered, and inspection showed that there was hardly a plate in her under bottom in which could not be found either a dent, a crack or a hole. The injuries comprised not only the plates, however, but also the stern-frame of the vessel, which was found to be broken in three places, and which, it was decided by the authorities at the yard, should be welded by the Thermit process.



FINISHED WELDS CHIPPED FLUSH.

The location of the different fractures in the stern-frame are shown in the accompanying illustrations of the Thermit welding operation, work on which was commenced Monday afternoon, January 31 last. On this date the fractures were cut open a distance of 1½ inches to allow for a free flow of Thermit steel so as to effect amalgamation with each side. The ends were then thoroughly cleaned by means of the Niagara Sand Blast and the wax patterns applied in accordance with standard Thermit practice.

The size of each of the sections to be welded was 6 inches by 10 inches, and the Thermit steel collar provided for was made 8 inches in width by 1½ inches thick at the center, the section of the collar being in the form of a segment of a circle. Mold boxes were then placed in position and the molding material packed around the wax patterns and the wooden patterns used for preheating gate, pouring gate and riser.

The weld in the horizontal member was made first, after which the two vertical members were welded simultaneously, this being done to prevent unequal contraction in cooling. Each of the fractures was brought to a bright red heat by means of a Thermit compressed-air gasoline preheater before the Thermit steel in the crucible was ignited and Thermit steel poured into the mold.

When the welds had entirely cooled the molds were removed and the metal left in the gates and risers cut away. It then became necessary to chip off the collars from two sides of each of the welds in order to permit the plates being replaced. This was done with pneumatic chipping hammers by workmen employed in the Navy Yard.

VARIATIONS OF ATMOSPHERIC PRESSURE AND THE METHANE CONTENT OF PIT AIR*

A number of experiments have shown that the methane content of pit air is influenced by the barometric pressure, inasmuch as the escape of the gas is retarded by increased pressure, and *vice versa,* the rate of change in the outflow being also dependent on the rapidity of the change of pressure, though the maximum or minimum of barometric pressure does not always coincide with a minimum or maximum gas content in the pit air.

The experiments in this direction have recently been continued at the Neunkirchen experimental gallery (Saarbrücken), on a more extended scale and under a wide range of conditions; and the results have been tabulated and plotted in a series of curves. A comparison between the methane curve and the curve of barometric pressure confirms the previous experience that a sharp fall in the latter is accompanied by a sharp rise in the former, and *vice versa,* the maximum and minimum pressures corresponding with minimum and maximum gas-content respectively. Furthermore, the maxima and minima of pressure were found to accord very nearly in point of time with the minima and maxima of gas-content, the interval between them being not more than a few hours at most. The agreement between the two was found closest where a rapid rise of pressure followed a sudden fall, the reversal of the curve being then frequently followed at once by a corresponding bend in the methane curve.

Very different results were obtained in the cases where the barometric pressure remained for some time approximately constant after reaching a maximum or minimum, or gradually rose or fell after being steady for some considerable time. In these circumstances, no direct influence of the pressure on the liberation of gas could be traced, the methane curve tending to remain steady, with merely slight fluctuations, until the next considerable variation of the barometer. When the steady pressure had been preceded by a maximum, the methane curve continued to rise to a certain height or to descend for a certain extent under the converse conditions, the ratio between the pressure and the methane curves being about the same in both cases. Consequently, slow changes in the height of the barometer have no appreciable effect on the course of the methane curve. The independence of the gas content, in the return-air current, with relation to the barometric pressure was confirmed by observations showing that the amplitude of the monthly variations in the methane content does not coincide at all with that of the atmospheric pressure, the former being frequently less in months when the barometric fluctuations were considerable than when these were slight. Analogous results were obtained by comparing the mean monthly barometric readings and methane content. If the volume of gas liberated were dependent entirely on the higher or lower barometric pressure, the months with a high mean position of the barometer would show a low mean gas content, and *vice versa* which is by no means the case. Furthermore, it appears that the mean gas content in any mine is a fairly constant factor (so long as the prevailing conditions of working remain unaltered), which does not vary except as the result of considerable fluctuations in the atmospheric pressure.

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The behaviour of the methane curve toward the barometer curve is capable of explanation by an examination of the factors determining the liberation of gas from the standing coal or from cavities. In the case of the coal the gas makes its way through fissures or from the exposed face; and in the former case the outburst usually occurs under such considerable pressure that the atmospheric pressure can have no appreciable influence thereon. In the case of the exposed coal a distinction must be drawn between coal that has already been got down, or is still hanging loosely to the face, and the actual firm standing coal. The first of these categories also includes undercut or blasted coal still lying at the working places, and such as is already loaded into the tubs. In this case the gas is no longer under pressure, so that it does not escape so long as the barometer remains steady. As soon, however, as the atmospheric pressure falls, the gas molecules expand and escape from the pores in the coal; and conversely, a rise in the barometer is accompanied by a penetration of air into the outer strata of the coal. Gas standing in the goaf or other cavities behaves in a similar manner, and apart from the results of diffusion, such gas does not increase the gas content of the pit air, except when the barometer falls. The degree of enrichment will be in proportion to the rapidity of the fall in pressure; and as soon as the downward movement of the barometer ceases, the escape of gas from the pores of the loose coal, or out of the cavities, is terminated for the time being.

The firm, standing coal, however, is a constant source of gas. Numerous experiments have proved that the gas is imprisoned in the seams under heavy pressure, which pressure gradually diminishes the nearer the coal face, so that it escapes there under merely slight pressure, that oftentimes is so near that of the atmosphere that no difference can be ascertained. Assuming the resistance offered by the pores of the coal to be a constant factor, the volume of the escaping gas depends on the difference between the pressure in the interior of the coal and the atmospheric pressure. Consequently, slight fluctuations in the latter—which amount to barely 1 per cent. of the former—cannot lead to any appreciable increase or diminution in the volume of gas liberated. The only occasions on which such changes in the escape of gas can occur are when the atmospheric pressure alters so rapidly the epuilibrium of the internal gas pressure is precluded. Whether, however, such disturbances of the regular escape of gas actually occur on sudden barometric fluctuations, is improbable. In any event they would be of merely brief duration, and would influence the behaviour of the gas curve in only the same manner as transitory liberations of gas from the loose coal or cavities, the gas curve tending always to return to a position corresponding with the mean liberation of gas, even in the case of a protracted barometric maximum or minimum succeeding a sudden change of pressure.

AMMONIA COMPRESSORS

By C. P. Wood.

Compressors may be vertical or horizontal, single- or double-acting, simple or compound. They may be cooled by oil or by a water jacket, or by saturated NH_3 gas.

Advantages claimed for vertical machines are, among others, small friction loss and consequent decrease in wear of piston and cylinder, also less probability of leakage due to worn cylinder or piston. Another advantage is that the rod does not rest heavily on the packing in the stuffing box, making it easier to keep the packing perfectly tight.

For the horizontal type, it is claimed that it will pump equally well either dry or saturated gas, that it requires very little more floor space than a vertical machine and much less head room, that the moving parts being near the base makes it easier for the strains to be resisted by the foundations, that all the parts are easily accessible from the floor.

An advantage of single-acting machines is that by the use of a safety head and a valve in the piston they can be operated without any clearance between piston and head, thus preventing one of the usually serious losses. Another advantage is that by using only the head end of the cylinder for compression, there is no loss due to leakage around the rod through the stuffing box, the pressure there being no higher than suction.

The double-acting machines, giving compression at each end of the stroke, have obvious advantages in high efficiency of both the steam and ammonia sides of the system, when all parts are considered at the same time instead of separately. The clearance loss has been reduced to a minimum in the best designs.

The loss due to clearance may be explained as follows: Suppose the high-pressure ammonia equals 180 pounds and the low-pressure 20 pounds; then the ratio is 1 to 9. Therefore, if the clearance equals 1/9 inch, the gas left in cylinder at the end of the compression stroke will take up 1 inch of space during suction stroke, keeping out that much fresh gas and reducing capacity accordingly.

This explains the desirability of having the piston travel the full length of the cylinder every stroke. The practical disadvantage of this is that when foul ammonia liquid or oil is drawn in in very large quantity, or when a valve breaks and gets into the cylinder, the machine is liable to be wrecked.

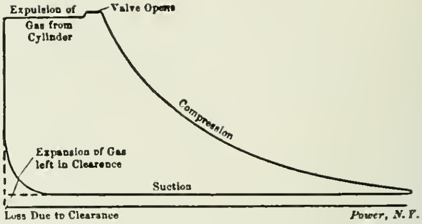
In single-acting vertical machines, the head can be held on by springs, strong enough to withstand the working pressure, which will relieve the machine in a case like that described.

In the De la Vergne system, oil is injected into the cylinder after the beginning of compression; this fills the clearance space, insuring complete expulsion of the gas, and is released through a passage which opens at the end of the stroke. Another function of this oil, which is cooled in a special oil cooler, is to take up the heat generated during compression, there being no water jacket to the cylinder.

Siebert has patented a bypass which opens at the end of the stroke, allowing the compressed gas confined in clearance to escape from the compression to the suction side of the piston.

It can be seen from the foregoing that the working space allowed for suction valves will have the same effect as clearance. When located in the heads, these valves are designed to fit flush, reducing loss as much as possible. The suction valve area generally allows for a gas velocity of about 4,000 to 4,500 feet per minute. The "Triumph" design has strainers over inlet valves to keep foreign substances out of the cylinder.

The accompanying indicator diagram shows graphically the cycle of events in the compressor cylinder. The space between the curve and the dotted line in the lower left-hand corner represents the loss due to clearance. The line of gas expulsion is perfectly straight when the valve works perfectly. The distance between the atmospheric line and the suction line represents suction pressure. Close-grained hammered steel, with a tensile strength about 75 per cent. greater than cast iron, is generally used for the manufacture of compressor cylinders.


Expulsion of Gas from Cylinder
Valve Opens
Compression
Expansion of Gas left in Clearance
Suction
Loss Due to Clearance

Power, N.Y.

INDICATOR DIAGRAM FROM AMMONIA COMPRESSOR

The stuffing box is an important part, especially in double-acting machines. Is is often divided into several compartments, sometimes employing oil or water under pressure. The cylinder should have indicator connections and provision for thermometers at the inlet and discharge. There should be a bypass, connected in such a way as to make it possible to exhaust the condensor by pumping the entire charge into the refrigerator, or *vice versa.*

The capacity of compressors is rated in two ways; (a) Ice-making capacity (tons of ice made in twenty-four hours); (b) refrigerating capacity (cooling work compared with melting one ton of ice in twenty-four hours). Power for driving compressors is provided at the rate of from 1.5 to 3 horsepower per ton of refrigerating capacity, depending upon the size of the machine. Except in very small machines, common practice is to drive with the Corliss engine. A popular design is a vertical compressor driven by a horizontal Corliss, the engine connecting rod and compressor connecting rod being mounted on the same crank pin. This is a good, compact design, especially with a twin compressor and cross-compound engine. The objection is that the length of stroke of the engine is limited to that of the compressor when a longer engine stroke would be more economical. There is a successful tandem horizontal design, i. e., with the ammonia-compressor piston mounted on the extension of the steam piston rod.

Compressors must have very heavy flywheels to insure uniformity of motion. In the best designs for gas-engine drive, the engine is belted to a countershaft, which is belted to the compressor. In case of electric-motor drive, the power is best transmitted by gears or by a noiseless chain of the Morse type.

ATMOSPHERIC HUMIDITY*

By Dr. William M. Grosvenor.

The following methods were developed as a matter of commercial necessity. They were needed to design a great number of drying installations adapted to meet widely different requirements, operating under a system the advantages of which have hitherto been largely overlooked, i. e., the repeated circulation of the same air over condensing coils to remove moisture, over heating pipes to increase the moisture capacity, over the material being dried, and again over the condenser.

Surprising steam economies are thus accomplished, in some cases amounting to more than 80 per cent. Insurance risks are reduced. So-called "moist drying" becomes a matter of course, great capacity is permitted, and complete independence of climatic conditions makes accurate design and perfect regulation possible.

The engineering of drying is to-day one of the most neglected and by no means one of the most simple branches of applied science. There are thousands of installations where the air is taken from the streets and the gutters and blown loaded with bacteria over fermentive products (many of them food stuffs), where it is received ice cold and heated up to 50 degrees or 100 degrees before it begins to do its profitable work, or is drawn in nearly saturated at 85 degrees to dry a product which cannot safely be heated above 95 degrees, where, worst of all, it is expected to reverse the performance of the widow's oil jug, and to keep on drinking up moisture indefinitely without renewal or dehydration. Taking advantage of the variable weather conditions, which the seller of machinery had no object in controlling, the machinery was made big enough—the bigger the better.

In developing simple, rapid, and at the same time reasonably accurate methods of design, we were met at once with the fundamental difficulty that there is no simple equation expressing the relation between the tension of aqueous vapor and the amount of water, either by volume or weight, saturating air under given conditions.

The next difficulty was that the base or divisor (cubic foot) of all humidity calculations has hitherto been most unfortunately selected, as it varies with every change of pressure, temperature, or humidity, needlessly complicating all calculations. Lastly that "percentage humidity," more properly called "degree of humidity," is not really comparable percentage at all. Ten per cent. of humidity means that 1 cu. ft. of moisture contains one-tenth the amount of water which a cubic foot of another mixture containing less air would carry if saturated under the same conditions of temperature and pressure.

While such a standard of humidity may be satisfactory for meteorological records, practical design in a field thus obstructed was a dangerous thing to turn over to subordinates, and it seemed advisable to begin by getting rid of stumpage and doing some grading. Finally there was marked disagreement in published tables of the essential constants.

The last question was first taken up. The original sources were examined and an entirely new set of calculations was made from vapor tensions to weight of water per cubic foot, using the following formulae and constants:

Density of air + .04% $CO_2 = \dfrac{1.293052}{1 + .00367 \times \text{Temp. C.}}$ in kg per cu. m).

Density of water vapor = .62186 × density air.

Ratio of density at partial pressure to density at 760 mm = 1/760 × partial pressure in mm.

Wt. in kg of 1 cu. m of residual air = 1/760 × part. press. × density of air (in kg per cu. m).

Wt. in kg of 1 cu. m of water vapor at part. pressure = 1/760 × 0.62186 part. pressure × density of air.

Specific heat water vapor = .475.

Specific heat of air = .2373.

Kg per cu. meter × .062428 = lb. per cu. ft.

Results of these calculations are given for every degree Fahrenheit in the table on the following page.

These results (Col. 3), differed by as much as 4 per cent. from the various published fig-

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*Reprinted from *Metallurgical and Chemical Engineering*, this being a part only of an abstract of a paper presented under a different title, at the Pittsburg meeting of the American Institute of Chemical Engineers.

Temp. F.	Vapor Tension in Millimeters	Lbs. Water Vapor per Pound Air	Humid Heat in B.T.U.	Humid Volume in Cu. Ft.	Density in Lbs. per Cu. Ft. @ 760 Millimeters		Specific Volume in Cu. Ft. per Lb. of—	
					Dry Air	Sat'd Mix.	Dry Air	Sat'd Mix.
1	2	3	4	5	6	7	8	9
32	4.569	.003761	.2391	12.462	.080726	.080556	12.388	12.414
33	4.746	.0039176	.2392	12.491	.080559	.080377	12.413	12.442
34	4.949	.0040763	.2392	12.521	.080393	.080198	12.439	12.469
35	5.152	.0042435	.2393	12.549	.080231	.080025	12.464	12.496
36	5.358	.0044151	.2394	12.578	.080069	.079852	12.489	12.523
37	5.572	.0045931	.2395	12.606	.079910	.079680	12.514	12.549
38	5.795	.0047781	.2396	12.636	.079748	.079511	12.539	12.576
39	6.023	.0049678	.2397	12.666	.079585	.079343	12.565	12.604
40	6.264	.0051678	.2398	12.695	.079420	.079181	12.590	12.629
41	6.507	.0053703	.2399	12.724	.079272	.079012	12.615	12.655
42	6.764	.0055849	.2400	12.754	.079113	.078849	12.640	12.682
43	7.026	.0058025	.2400	12.784	.078954	.078677	12.666	12.710
44	7.301	.0060320	.2401	12.813	.078797	.078514	12.692	12.736
45	7.582	.0062670	.2403	12.843	.078641	.078348	12.718	12.763
46	7.874	.0065103	.2404	12.872	.078485	.078178	12.741	12.791
47	8.177	.0067636	.2405	12.904	.078329	.078011	12.766	12.819
48	8.486	.0070239	.2407	12.935	.078172	.077844	12.792	12.846
49	8.811	.0072942	.2408	12.968	.078019	.077678	12.817	12.874
50	9.140	.0075697	.2409	12.999	.077867	.077511	12.842	12.901
51	9.488	.0078620	.2410	13.030	.077714	.077344	12.868	12.927
52	9.841	.0081579	.2411	13.062	.077562	.077178	12.893	12.957
53	10.210	.0084683	.2413	13.095	.077409	.077016	12.919	12.984
54	10.589	.0087865	.2415	13.127	.077258	.076851	12.944	13.012
55	10.980	.0091163	.2416	13.159	.077109	.076685	12.968	13.041
56	11.386	.0094583	.2418	13.192	.076926	.076522	12.993	13.068
57	11.801	.0098064	.2420	13.224	.076810	.076363	13.019	13.096
58	12.235	.010165	.2421	13.258	.076661	.076198	13.044	13.124
59	12.674	.010546	.2423	13.292	.076512	.076032	13.070	13.152
60	13.138	.010939	.2425	13.326	.076363	.075865	13.095	13.180
61	13.608	.011338	.2427	13.360	.076215	.075698	13.121	13.210
62	14.100	.011755	.2429	13.395	.076069	.075529	13.146	13.240
63	14.603	.012182	.2431	13.431	.075924	.075362	13.171	13.270
64	15.122	.012625	.2433	13.467	.075799	.075198	13.196	13.298
65	15.660	.013081	.2435	13.501	.075635	.075039	13.222	13.325
66	16.209	.013547	.2438	13.535	.075493	.074882	13.246	13.354
67	16.783	.014043	.2440	13.572	.075347	.074718	13.272	13.384
68	17.363	.014539	.2442	13.609	.075201	.074552	13.298	13.413
69	17.975	.015065	.2444	13.645	.075062	.074387	13.323	13.441
70	18.595	.015597	.2447	13.683	.074921	.074219	13.348	13.471
71	19.242	.016154	.2450	13.720	.074778	.074054	13.373	13.502
72	19.903	.016724	.2452	13.759	.074636	.073899	13.398	13.532
73	20.555	.017312	.2455	13.797	.074496	.073735	13.424	13.562
74	21.289	.017922	.2458	13.837	.074363	.073570	13.449	13.593
75	22.008	.018545	.2461	13.876	.074218	.073405	13.474	13.624
76	22.759	.019198	.2464	13.916	.074079	.073239	13.499	13.654
77	23.517	.019857	.2467	13.956	.073940	.073072	13.524	13.685
78	24.315	.020554	.2470	13.997	.073801	.072909	13.549	13.715
79	25.124	.021260	.2474	14.039	.073663	.072747	13.575	13.746
80	25.965	.021998	.2478	14.081	.073531	.072585	13.600	13.777
81	26.724	.022752	.2481	14.123	.073395	.072419	13.625	13.809
82	27.711	.023532	.2485	14.167	.073258	.072248	13.650	13.841
83	28.625	.024339	.2488	14.211	.073123	.072080	13.675	13.873
84	29.557	.025164	.2492	14.255	.072987	.071913	13.701	13.906
85	30.529	.026026	.2497	14.301	.072852	.071744	13.726	13.938
86	31.519	.026898	.2501	14.347	.072716	.071574	13.752	13.971
87	32.518	.027818	.2505	14.399	.072584	.071404	13.776	14.004
88	33.582	.028750	.2510	14.442	.072453	.071234	13.801	14.038
89	34.667	.029724	.2514	14.490	.072321	.071064	13.827	14.072
90	35.774	.030718	.2519	14.539	.072189	.070894	13.852	14.106
91	36.913	.031747	.2524	14.588	.072058	.070724	13.787	14.139
92	38.087	.032810	.2529	14.638	.071926	.070556	13.903	14.173
93	39.283	.033896	.2534	14.688	.071794	.070390	13.929	14.206
94	40.528	.035029	.2539	14.740	.071664	.070221	13.954	14.241
95	41.784	.036174	.2545	14.793	.071535	.070051	13.979	14.275
96	43.102	.037388	.2550	14.846	.071407	.069878	14.004	14.310
97	44.434	.038603	.2556	14.900	.071279	.069704	14.030	14.346
98	46.824	.039817	.2562	14.956	.071149	.069530	14.055	14.582
99	47.228	.041206	.2569	15.013	.071021	.069356	14.080	14.419
100	48.679	.042557	.2575	15.071	.070894	.069179	14.106	14.455
101	50.171	.043955	.2582	15.131	.070767	.069002	14.131	14.492
102	51.691	.045382	.2589	15.192	.070641	.068825	14.155	14.530
103	53.271	.046876	.2596	15.253	.070514	.068645	14.181	14.568
104	54.865	.048385	.2603	15.313	.070387	.068464	14.207	14.606
105	56.534	.049973	.2610	15.376	.070264	.068288	14.232	14.643
106	58.219	.051582	.2618	15.440	.070141	.068110	14.257	14.682
107	59.968	.053271	.2626	15.506	.070018	.067926	14.282	14.722
108	61.749	.054996	.2634	15.572	.069894	.067745	14.307	14.761
109	63.578	.056634	.2643	15.640	.069751	.067568	14.333	14.800
110	65.459	.058613	.2651	15.711	.069647	.067383	14.358	14.840
111	67.374	.060492	.2660	15.783	.069525	.067192	14.384	14.883
112	69.359	.062456	.2670	15.854	.069403	.067007	14.409	14.924
113	71.362	.064442	.2679	15.930	.069281	.066823	14.434	14.965
114	73.455	. 66540	.2689	16.006	.069167	.066636	14.459	15.008
115	75.569	.068662	.2699	16.084	.069040	.066447	14.484	15.050
116	77.757	.070881	.2710	16.164	.068920	.066253	14.509	15.094
117	79.986	.073150	.2720	16.245	.068800	.066061	14.535	15.137
118	82.273	.075514	.2732	16.328	.068681	.065871	14.560	15.179
119	84.621	.077921	.2743	16.413	.068562	.065675	14.585	15.225
120	87.010	.080402	.2755	16.499	.068443	.065477	14.611	15.272
121	89.479	.082995	.2767	16.592	.068325	.065280	14.636	15.319

Temp. F.	Vapor Tension in Millimeters	Lbs. Water Vapor Per pound Air	Humid Heat in B. T. U.	Humid Volume in Cu. Ft.	Density in Lbs. per Cu. Ft. @ 760 Millimeters		Specific Volume in Cu. Ft. per Lb. of—	
					Dry Air	Sat'd Mix.	Dry Air	Sat'd Mix.
1	2	3	4	5	6	7	8	9
122	91.978	.085622	.2780	16.679	.068207	.065082	14.661	15.365
123	94.581	.088398	.2793	16.777	.068090	.064884	14.686	15.412
124	97.207	.091208	.2806	16.870	.067973	.064689	14.711	15.460
125	99.924	.094147	.2820	16.968	.067857	.064480	14.736	15.509
126	102.688	.09716	.2835	17.069	.067741	.064277	14.762	15.558
127	105.518	.10027	.2849	17.172	.067625	.064075	14.788	15.606
128	108.428	.10350	.2864	17.278	.067510	.063870	14.813	15.657
129	111.382	.10680	.2880	17.386	.067394	.063663	14.838	15.708
130	114.437	.11022	.2896	17.499	.067280	.063449	14.863	15.761
131	117.516	.11368	.2913	17.612	.067166	.063234	14.888	15.814
132	120.724	.11742	.2931	17.730	.067052	.063022	14.914	15.867
133	123.960	.12121	.2949	17.851	.066938	.062809	14.939	15.921
134	127.304	.12514	.2968	17.976	.066826	.062591	14.964	15.977
135	130.702	.12917	.2987	18.103	.066713	.062374	14.989	16.032
136	134.182	.13335	.3006	18.235	.066601	.062158	15.015	16.088
137	137.749	.13768	.3026	18.370	.066489	.061939	15.040	16.145
138	141.372	.14122	.3047	18.508	.066377	.061717	15.065	16.204
139	145.114	.14678	.3070	18.653	.066267	.061487	15.090	16.264
140	148.885	.15150	.3093	18.800	.066156	.061255	15.116	16.325
141	152.807	.15652	.3117	18.952	.066045	.061022	15.141	16.387
142	156.762	.16161	.3141	19.108	.065935	.060790	15.166	16.450
143	160.841	.16696	.3166	19.270	.065823	.060554	15.192	16.512
144	164.986	.17245	.3192	19.437	.065712	.060318	15.217	16.576
145	169.227	.17816	.3219	19.609	.065601	.060082	15.242	16.643
146	173.569	.18409	.3247	19.787	.065498	.060842	15.267	16.710
147	177.976	.19017	.3276	19.971	.065390	.060599	15.293	16.780
148	182.522	.19659	.3307	20.161	.065283	.060353	15.318	16.846
149	187.103	.20310	.3338	20.354	.065176	.059106	15.343	16.919
150	191.860	.21005	.3371	20.559	.065068	.058865	15.368	16.993
151	196.654	.21710	.3404	20.767	.064962	.058605	15.394	17.068
152	201.595	.22455	.3440	20.987	.064856	.058349	15.419	17.141
153	206.610	.23221	.3476	21.211	.064750	.058092	15.444	17.215
154	211.739	.24019	.3514	21.445	.064644	.057833	15.469	17.291
155	216.983	.24854	.3553	21.687	.064539	.057570	15.494	17.370
156	222.305	.25713	.3594	21.936	.064425	.057305	15.520	17.450
157	227.786	.26623	.3637	22.201	.064328	.057036	15.545	17.533
158	233.308	.27546	.3681	22.468	.064224	.056767	15.570	17.616
159	239.034	.28542	.3728	22.754	.064120	.056493	15.596	17.701
160	244.803	.29553	.3776	23.045	.064016	.056218	15.621	17.788
161	250.742	.30627	.3827	23.382	.063913	.055938	15.646	17.877
162	256.767	.31737	.3880	23.670	.063810	.055656	15.671	17.968
163	262.923	.32900	.3936	24.001	.063707	.055372	15.697	18.060
164	269.213	.34123	.3994	24.349	.063605	.055084	17.722	18.154
165	275.592	.35385	.4054	24.708	.063502	.054795	15.748	18.250
166	282.155	.36733	.4118	25.090	.063400	.054500	15.772	18.349
167	288.764	.38106	.4183	25.478	.063298	.054203	15.798	18.449
168	295.609	.39602	.4254	25.900	.063198	.053901	15.823	18.545
169	302.504	.41125	.4327	26.300	.063098	.053598	15.848	18.654
170	309.593	.42756	.4405	26.790	.062997	.053292	15.874	18.761
171	316.781	.44472	.4485	27.267	.062899	.052983	15.899	18.875
172	324.120	.46257	.4570	27.768	.062799	.052670	15.924	18.986
173	331.612	.48162	.4660	28.301	.062699	.052353	15.949	19.101
174	339.207	.50140	.4754	28.855	.062599	.052032	15.975	19.218
175	347.015	.52285	.4856	29.454	.062500	.051708	16.000	19.339
176	354.873	.54472	.4960	30.063	.063402	.051382	16.025	19.462
177	363.003	.56901	.5076	30.738	.062304	.051049	16.050	19.589
178	371.190	.59386	.5194	31.428	.062207	.050715	16.076	19.719
179	379.598	.62097	.5322	32.180	.062112	.050378	16.101	19.851
180	388.121	.64942	.5458	32.967	.062015	.050035	16.126	19.987
181	396.815	.67985	.5602	33.810	.061915	.049693	16.152	20.126
182	405.686	.71265	.5758	34.717	.061816	.049338	16.177	20.269
183	414.674	.74703	.5921	35.666	.061719	.048985	16.202	20.415
184	423.904	.78519	.6102	36.718	.061623	.048626	16.227	20.566
185	433.194	.82430	.6288	37.796	.061529	.048265	16.253	20.719
186	442.793	.86911	.6501	39.029	.061434	.047898	16.278	20.879
187	452.456	.91535	.6721	40.302	.061339	.047529	16.303	21.041
188	462.374	.96731	.6967	41.729	.061244	.047153	16.328	21.209
189	472.422	1.0227	.7230	43.251	.061149	.046774	16.353	21.381
190	482.668	1.0835	.7519	44.918	.061053	.046391	16.379	21.557
191	493.111	1.1510	.7843	46.768	.060961	.046003	16.404	21.739
192	503.690	1.2230	.8190	48.739	.060867	.045611	14.429	21.925
193	514.545	1.3067	.8579	51.021	.060774	.045213	16.454	22.119
194	525.368	1.3933	.8990	53.402	.060681	.044813	16.480	22.315
195	536.744	1.4994	.9494	56.302	.060588	.044405	16.505	22.521
196	548.093	1.6108	1.0023	59.349	.060496	.043997	16.530	22.730
197	559.731	1.7436	1.0714	62.978	.060403	.043586	16.556	22.945
198	571.519	1.8912	1.1358	67.024	.060311	.043169	16.581	23.166
199	583.531	2.0629	1.2171	71.696	.060219	.042742	16.606	23.393
200	595.771	2.2680	1.3147	77.304	.060127	.042308	16.631	23.638
201	608.155	2.4968	1.4231	83.537	.060036	.041868	16.656	23.886
202	620.871	2.7987	1.5665	91.768	.059946	.041425	16.682	24.142
203	633.657	3.1189	1.7186	100.499	.059855	.040982	16.707	24.401
204	646.845	3.6509	1.9159	115.210	.059764	.040530	16.732	24.675
205	660.116	4.2272	2.1562	131.028	.059674	.040075	16.758	24.954
206	673.718	4.9776	2.5681	151.272	.059585	.039610	16.783	25.248
207	687.489	6.0698	3.1238	180.906	.059495	.039143	16.808	25.549
208	701.516	7.6748	3.8948	224.623	.059406	.038673	16.834	25.860
209	715.805	11.1295	6.2569	362.091	.059317	.038049	16.858	26.289
210	730.267	15.8174	15.9148	562.054	.059228	.037323	16.884	26.796

ATMOSPHERIC HUMIDITY TABLE.

ures, but showed a surprising agreement (¼ per cent. due to allowance of 0.04 per cent. CO_2) with the figures of the United States Weather Bureau. The reason for this was inquired into. Quoting from the Psychrometric Tables of the United States Weather Bureau of 1900 (prepared by Dr. C. F. Marvin, Professor of Meteorology), it will be seen how carefully the Weather Bureau's table were prepared:

"The vapor pressures employed were derived from Broch's reduction of Regnault's observations. All the values given by these tables at temperatures below the freezing point are noticeably higher than Regnault's observations. In view of this systematic discordance and the further circumstance that Regnault's experiments did not include observations at the extremely low temperatures frequently recorded at Weather Bureau stations, the writer (Dr.

Marvin), in 1891, made a new determination of the maximum pressure of aqueous vapor at low temperatures.

"In the course of these experiments it was found an easy matter to reduce the temperature of the water employed many degrees below 32 degrees Fahr., without freezing it, and in these cases the vapor pressure was higher than the pressure from ice at the same temperature. Independent experiments in Sweden, by Julius Johlin, at about this time, led to the same results.

"A comparison of the vapor pressures derived from the several sources mentioned shows that Broch's computed values at low temperatures do not agree at all well with Regnault's experiments, from which they are derived, whereas the experimental results of Regnault, Johlin, and the writer (Dr. Marvin), agree very closely.

"At temperatures below 32 degrees Fahr., therefore, it has been considered necessary to reject Broch"s values, and the vapor pressures over ice, as deduced from the writer's experiments, have been used in the calculation of the tables. At temperatures above 32 degrees Fahr. the values taken from Broch's tables are employed. At 32 degrees Fahr. the value for the vapor pressure found by the writer from the mean of a large number of experiments was identical with that of Broch; hence, there is no break in the continuity of the two tables at the point of junction."

The calculated weight of water per pound of air does not agree with actual determinations, but shows progressive differences, possibly owing to association of molecules in the vapor, which are too small in magnitude, however, to affect our present purpose.

Regarding this difference Dr. Marvin writes:

"In all ordinary circumstances it is assumed that the expansion and contraction of partially saturated aqueous vapor is in accordance with the same laws as apply to air and ordinary gases, which do not easily condense to the liquid state.

"The adopted density of saturated aqueous vapor is not determined directly from experiment, but is deduced theoretically from the observed fact that two volumes of hydrogen and one of oxygen combine to produce two volumes of water vapor.

"The weights of unit volumes of hydrogen, oxygen, and dry air are accurately known, from which the specific gravity of aqueous vapor is found to be 0.6221."

The compared figures from various sources were submitted to Dr. Marvin, but he replied that, "The Weather Bureau has not attempted to measure the quantity desired directly; in fact, the difficulty of experimentally maintaining a condition of absolute saturation and avoiding supersaturation, or mechanically suspended moisture on the one hand and superheating on the other, is so great as to perhaps render the results thus obtained less acceptable than the theoretical values."

We must, therefore, accept these figures as generally recognized throughout the United States and at least as well established as our purpose requires.

COMPUTING THE FORCE OF A HAMMER BLOW

By S. B. Redfield.

Some time ago the catalog of a manufacturer of rock drills came into my hands and under the specifications of each of the different sizes of drill was given the item "Force of the Blow Delivered."

Upon taking up the matter with the manufacturers' engineers, as a matter of interest, it was admitted that nobody knew where the figures had come from, nor how they were calculated. They had simply been handed down from edition to edition of the catalog, always using the previous edition as authority.

In Kent's "Mechanical Engineers' Pocket Book," on page 430, is the following statement referring to the question of the force of a blow: "The question cannot be answered directly and it is based upon a misconception or ignorance of fundamental mechanical laws."

There is a great deal of this "misconception" (I hesitate to say "ignorance") and some remarks on the subject should be of interest.

When a body of a given weight is lifted through a given distance, work is done upon that body against the action of gravity, equal to the product of the weight by the distance lifted through. When this body is allowed to fall again, this work is transformed into energy of motion and when the body strikes an obstacle, the act of stopping the body forces it to give up its energy of motion, resulting in deformation or breakage and heat.

Just as the work done upon the body in

lifting it against gravity is the product of a force (weight) and a distance (height) so the work done when the body stops falling must be the product of a force and a distance. The distance is the penetration of one of the bodies into the other, or the deformation, and the force exerted is the "force of the blow" about which we are talking. As the work done by the blow must equal the work stored in the falling body, the product of the force of the blow and the depth of penetration must be constant and equal to this stored work. If the substances are tough and penetration is slight, the force of the blow must be correspondingly great. Similarly, if the bodies are soft and penetration is relatively great, the force of the blow must be relatively small, because, as said, the product of the two must be constant.

As an example let us take a 2000-pound drop hammer and let it fall upon the work from a height of 5 feet. Now, neglecting friction in order to simplify matters, when that hammer was raised up to the height of 5 feet by the driving mechanism, the work done upon it was the product of the weight and the distance, or 10,000 foot-pounds.

When released, the hammer will fall and, again neglecting friction, the 10,000 foot-pounds of stored work or energy which it received from the driving belt, will have been transformed into velocity and when it strikes the piece on the anvil block this velocity will again be changed back into work; the product of force and distance.

Suppose, for instance, that the deformation of the piece allows the hammer to sink down half an inch after it first strikes. This is the "distance" and is 1-24 of a foot. Since the total work available in the moving hammer head is 10,000 foot-pounds and since the distance moved through while the hammer is giving up this work is 1-24 of a foot, the average force exerted upon the piece must be 10,000 divided by 1-24 or 240,000 pounds. This is the force of this particular blow.

Now suppose the piece is harder than that just considered, and that when the 2000-pound head has dropped 5 feet, the penetration after striking the piece is only ¼ inch or 1-48 foot. Then by the same reasoning as before, the average force exerted must be 10,000 divided by 1-48 or 480,000 pounds.

Thus it is seen that the force of the blow depends upon the hardness of the body struck, for the harder it is, the less the penetration or "distance" and so, the greater the force of the blow must be.

Similarly, if the piece were very soft, and the penetration were, say 2 inches or 1-6 foot, the average force of the blow would be 10-000 divided by 1-6 or 60,000 pounds.

So far, we have considered only a falling weight. Let us return to the case of the rock drill. Suppose that a 3½-inch diameter drill has an average effective air pressure behind its piston, of 60 pounds per square inch; that the moving parts—piston, piston rod and steel—weigh 100 pounds and have a total stroke of 9 inches. Also let the penetration into the rock be 1-16 inch at a blow.

Here the problem is complicated by the work done by the air on the downward stroke. We will simplify the case by assuming that the air pressure is removed exactly at the instant of stopping and that there is no cushioning of air in the lower end of the cylinder.

In falling through the 9-inch stroke (¾ foot), the 100 pounds of weight will be able to do 100×¾=75 foot-pounds of work. The average air pressure of 60 pounds per square inch above the 3½-inch diameter piston will exert a downward force of 60×9.62=577 pounds. This, acting through the 9-inch stroke, would put energy, or work, into the parts to the amount of 577×¾=432 foot-pounds. This would show itself in increased velocity of the moving parts.

From this we have that the total work available in the descending mechanism, again neglecting friction, would be 75+432=507 foot-pounds. Since the penetration is 1-16 inch or 1-192 of a foot, the average force of the blow will be 507 divided by 1-192 or 97,344 pounds.

Again, if the rock were very soft and the penetration were twice as great, the average force would be half as much or 48,672 pounds.

This same method of reasoning might be applied to a steam hammer with the result that a 24,000-pound hammer with a 36-inch diameter piston having 30 pounds average effective steam pressure behind it, dropping 6 feet and penetrating 1 inch would exert an average force of blow of 3,927,000 pounds.

A common-sense example of the fact that the force of this blow depends upon the resisting power of the piece struck, is that a certain blow which would fracture a piece of hardened steel might do no harm at all to a piece of rubber. The steel would be penetrated so little that the enormous force resulting would fracture it, while the great movement of the rubber would allow the force of the blow to be so small as to do no damage.

The question may be asked, "What becomes of this work that is delivered by the falling weight?" It is used up in deforming and heating the piece which is struck by it, and also, to considerable extent, in the rebound of the parts, vibration of the earth, etc. This last phenomenon is a clear evidence of the force of the blow of a steam hammer. When the piece being forged is hot and soft, the vibration of the earth is nowhere near so great as when it becomes cold and hard, offering more resistance to the blow, with the same drop and steam admission.

As indicated, the force of the blow calculated in this manner is only the average force during the time of crushing the materials. At the first contact, the material would be softer than after compression and consequently the force of the blow delivered would be comparatively light at first, rapidly increasing to a high maximum many times greater than the calculated average, as the particles become more crowded together, stopping the motion of the falling hammer. For this reason the calculation of the actual "force of a blow" at any instant is even more indeterminate than might at first be supposed—*American Machinist.*

CONDENSERS WITHOUT AIR PUMPS

A new type of steam condenser in which the usual air pump is entirely dispensed with has appeared in Europe. Circulating and condensed water pumps are required, but the air is extracted from the air chamber by the circulating water on the ejector principle. The cold circulating water is drawn from the cooling tower tanks by a centrifugal pump, which imparts to it sufficient head to overcome the tube friction and to raise it to the top of the towers. The water enters the condenser with a somewhat higher velocity than is usual, and first passes through an ejector apparatus in the air chamber, which entraps the air, causing it to be carried out of the condenser with the circulating water. This arrangement is said to be suitable for any kind of steam plant, especially where a high and steady vacuum is required. Several such condensers are at work in Germany. One installed at Charlottenburg gave, it is reported, on test a vacuum of over 95 per cent. Both the pumps, that for circulating the cold water and that for the extraction of the hot condensed water, may be of the centrifugal type, and this fact, coupled with the absence of an air pump, reduces to a very large degree the liability of stoppages.

Although the circulating water pump is necessarily somewhat more powerful than in ordinary condenser plant of equal capacity, the total power required for the auxiliaries is said to be reduced. The chief advantages claimed for the system are the low running costs and the greater safety of working. Further, there is said to be a saving in first cost and in floor space.

TUNNELING UNDER AIR PRESSURE

There is considerable difference between horizontal and vertical excavation. In vertical work there are no overlaying strata. In the case of the tunnel the weight of material overhead becomes a very serious factor indeed. An air tension equal to the hydraulic pressure will keep the water out from every direction. But the solid material overhead may, under exceptional circumstances, be pressed down by a pressure comparable with its actual weight. This is about two and one-half times that of water. Under ordinary conditions the overlying strata are self-supporting a short distance above a tunnel. Between the lowest point of self-support and the roof of the tunnel lies material whose fall is to be expected. The air pressure, whether great or small, cannot be relied on to support this. The reason for this circumstance is the porosity of the soil. If the compressed air could not penetrate the earth and get above it and the imbedded boulders, then the air pressure might be expected, ordinarily, to assist in keeping the roof intact. But with the air pressure above and below its particles the same, the material will fall under the influence of gravitation. It is necessary, then, to provide an air pressure to withstand hydraulic thrusts and a mechanical support to oppose the weight of overlying loose material.

WEIGHING THE ATMOSPHERE IN DETAIL

The modern chemist is a modest man. He is not wont to boast of his achievements, nor to lay claim to a godlike knowledge of earthly things. And yet up to 1894 he thought that he knew all that there was to be known about the composition of air. In that year two distinguished English physicists announced that they had found a new gas in our atmosphere. Apart from the value of that achievement the discovery was of interest because the new gas, unlike any of the other constituents of air, refused to combine with other substances. Because of this lack of chemical affinity the gas was named "argon" (the idle one).

Since the discovery of argon, still other unsuspected constituents of our atmosphere have been discovered by Sir William Ramsey. Besides argon, he has given the world "neon" (the new one), "krypton" (the hidden one), and "xenon" (the stranger). All of these gases are contained in the air in infinitesimal quantities.

In the course of his investigations of these rare gases Sir William Ramsey found it necessary to weigh given amounts of them. He was confronted with the difficulty of not possessing a balance delicate enough; for these gases are marvelously light. Accordingly he set about the construction of one. It has recently been completed, and may well be regarded as the most delicate balance in the world.

So sensitive is this weighing apparatus that it is housed in a subterranean chamber, where the temperature is constant all the year round and where it will not be disturbed by street vibrations. The weighing must be done also in a dark room; for an ordinary light would markedly heat the instrument and vitiate its readings. When properly adjusted, the scale will detect a difference in weight of one seven-billionth of an ounce.

The utter impossibility of securing weights small enough to weigh a gas so light as xenon or krypton has rendered it necessary to employ the gases themselves as weights. The tiny tube in which one of these gases is contained is placed upon the scale and a reading is taken. Thereupon the tube is opened and the gas released and the inrushing air exhausted. Once more the tube is weighed. The difference between the two weighings is the weight of the gas.

The finest metallic weight thus far made weighs one one-million-five-hundred-thousandth of an ounce—much too coarse for weighing the rarer gases.

So slight is the movement of the scale beam that it cannot be detected by the eye, and must be magnified. Hence, the weight of the gas is indicated by a small mirror, upon which a minute pencil of light is thrown and reflected upon a graduated black scale.—*Saturday Evening Post.*

TIDES OF THE ATMOSPHERE

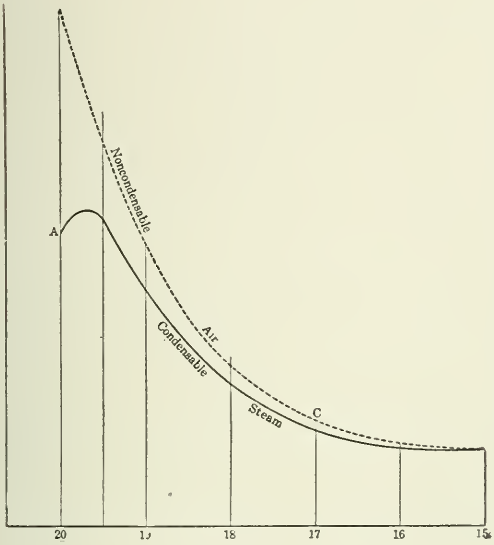
Most people know that tides are caused by the pull of the moon and sun on the waters of the earth; but knowledge that tides are also caused in the upper air is not quite so universal. Our earth is surrounded by a big ocean of air, which has a great deal more mobility than water or anything else we can imagine. The moon is the chief attracting force, and, consequently, a great hump is made in our air directly beneath the moon, and is held in place by the moon's attraction. This hump always points toward the moon, and as the earth rotates the hump travels around it.

Aerial tides are like water tides: they appear in like phases at opposite points on the earth; so we should have two aerial tides every day, as we have two water tides daily. As the air is easier in its motion, so the hump can follow the moon easier. This would make the aerial tides come just before the water tides at any particular point on the earth.

As to the relation of these tides to man, not much was said until the flying machine succeeded in reaching great heights. Then their effect had to be taken into account.

The most wonderful thing in the aerial line, however, is the top current sweeping around the earth. It is of course understood that the earth rotates from west to east. The air, being free to move, follows the earth in varying velocities only until, when the uppermost regions of the air are reached, the rate of its velocity is far behind that of the earth, which is a thousand miles an hour. This being the case, it would have the effect of a current going from east to west at a velocity determined by the slowness with which it followed the earth. This velocity is approximately 76 miles an hour.

The way in which it was determined is historical and somewhat interesting. In the '80's a volcano known as Krakatua sent forth over a cubic mile of matter. Much of this, being very light, was carried into the uppermost regions of the atmosphere. It was observed by people all over the earth; for it made the complete circuit of the globe no less than seven times. People now living can recall the glorious sunsets occasioned by reflected sunlight on the clouds of dust. Its average rate of travel was 76 miles an hour.



RECOMPRESSION OF STEAM AND AIR

The advent of the steam engine indicator, and its general use by the leading engineers did more to develop the details of economical steam engineering practice than all the abstract reasoning of all the engineers who had preceded it. This it did largely by still farther stimulating the reasoning faculty, but at the same time supplying checks and guides for the reasoning. The discussions are as lively as ever, and still there are questions which are far from settled. Recently in the technical press, and especially in Power and the Engineer, there has been discussion of the effect and value of the recompression of a portion of the steam remaining in the cylinder upon the return stroke. The compression of a considerable volume of the steam for the purpose of filling the clearance space in the cylinder, instead of filling it at every stroke with new steam from the boiler, has been approved by many, but a careful measuring of steam actually consumed has not shown the expected saving.

The explanation is furnished by the indicator. In a great many cases there has appeared in indicator cards taken from steam cylinders a hook at the upper termination of the compression line, as at *A* in the accompanying diagram, and this has been variously accounted for. A favorite explanation has been that this hook when the pressure has risen sufficiently is caused by leakage of piston or valves, or both. If leakage was the cause the same hook would appear when the same pressure was reached if compressed air was used instead of steam as the motor fluid. As a matter of fact the hook does not appear when air is used, the compression line running up with perfect smoothness until the end of the stroke is reached, as shown in the diagram.

Elaborate and protracted investigations conducted by Professor Dwelshauvers-Dery, a resume of which forms the *piece de resistance* in a recent issue of Power and the Engineer, demonstrated that the more compression his engine had the less the energy it developed per pound of steam consumed, on account of the condensation which occurred, a phenomenon entirely absent in similar compression of compressed air.

AN AERIAL LIGHTHOUSE

There has been keen discussion in Germany regarding the best methods for enabling aerial travelers to establish their location after nightfall and in foggy weather. While no one system has yet received official or professional sanction, an initial step has been taken at the town of Spandau in Prussia, where an aerial lighthouse is in full activity. It consists of an elevated support on which rests in a horizontal position a wooden ring of considerable diameter with 38 powerful incandescent lights around the circumference and an automatic arrangement for interrupting the current at regular intervals. A traveler over the place sees at night a large luminous circle alternately appearing and disappearing. This apparatus of course is of no use in fogs making it necessary to install also a siren or other noise maker.

OIL FUEL IN THE FOUNDRY

Taking into account convenience and cleanliness, oil is a cheaper fuel than coal for many industrial purposes. For this reason oil is being used to an increasing extent for baking cores, drying molds and heating ladles, and melting in brass, iron and steel foundries; for smelting, melting and refining in metallurgical establishments, and for a great variety of other processes where high temperatures are desired.

Where a furnace is used, it generally consists of a chamber, often of large dimensions, lined with firebrick, upon the floor of which is placed the object to be heated. The oil, together with some of the air for combustion, enters at one side from one or more jets or burners, and the burning blast impinges on the object to be heated. Sometimes the chamber is rectangular and the jets are directed immediately upon the object. In other cases there are bays or side-chambers to give opportunity for complete combustion previous to the main chamber. There must, of course, be an outlet for the products of combustion after they have given up their heat. A furnace of this type is much simpler than one where coal is used as fuel, for with coal there must be a grate, a combustion chamber and an ash-pit. There is, in addition, the expense of firing, clinkering and removal of ashes. Oil fuel is usually stored in tanks and delivered by pumps, and the storage and delivery are usually a simpler problem than in the case of coal.

So far as cost of a heat unit is concerned, coal is possibly a cheaper fuel at the present price of oil; but taking into account all of the incidentals, the total cost with oil is, in many cases, much less.

Two kinds of oil are in use at the present time. One is crude oil just as it comes from the well, while the other is a residue remaining after some of the more valuable products have been extracted. The nature of this residue varies considerably at different places and at different periods.

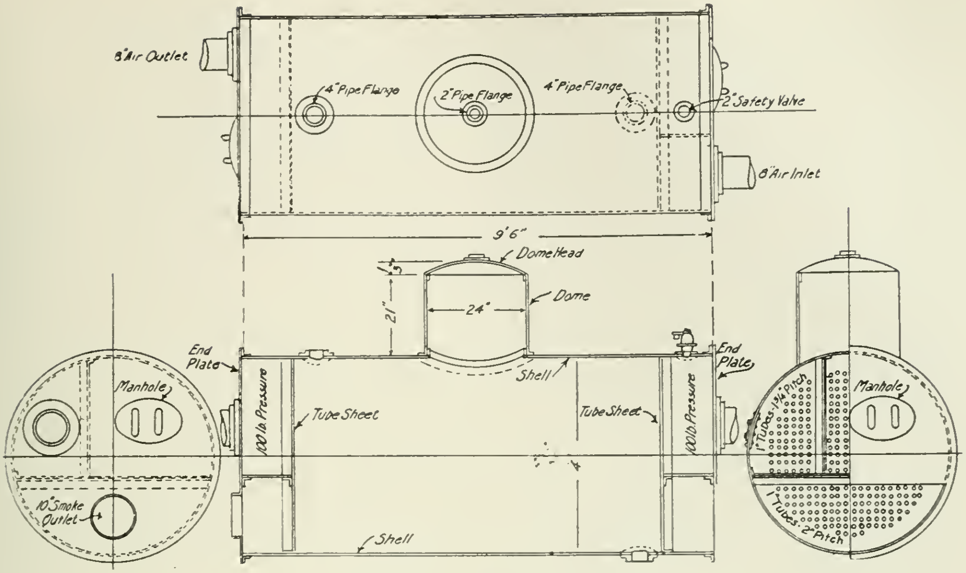
In order that the oil may burn in a proper manner and in a reasonable space without smoke, it must be intimately mixed with the air necessary for combustion. The oil is, therefore, reduced by a "burner" to very small drops, each surrounded by air for its combustion. This is called atomization. The drops must be of very small size, since a drop of appreciable size, even though it is surrounded by the entire amount of air necessary for its combustion, will proceed for a considerable distance from the burner, as a small ball of yellow flame, before it is completely burned.

The burners for producing the proper type of jet are of many shapes. There is always a pipe carrying oil under pressure leading through the burner. There is usually an additional pipe carrying compressed air or steam for the atomization. In the case of oil burners for steam boilers the jet is usually steam, while for industrial purposes the jet is usually compressed air. Some of the air for combustion is entrained or sucked in by the velocity of the jet issuing from the burner. In the case of steam atomization the entire amount of air must be supplied in this way. With air atomization the amount supplied under pressure and the amount entrained differ with the type of burner. There are many standard burners on the market, and, in addition many of the plants which burn oil have special devices of their own. The arrangements are, therefore, numerous, and no general description can be given. There are, however, the following general classes:—

The compressed air may be supplied at a pressure of from 15 to 30 pounds per square inch. In such cases the compressed air usually forms a comparatively small portion of that necessary for combustion, and the main air is entrained by the high velocity or sucked in by the chimney draft. In one such system the main air is supplied by a forced draft given by a fan blower delivering the air through a pipe ending near the burner at a comparatively low velocity.

In other cases the compressed air is supplied at a pressure of from 1 to 4 pounds per square inch. In these cases, probably the greater portion of the air is supplied by the compressor, and a comparatively small amount is entrained. However, it is difficult to make a positive statement in this matter. The designers of the various burners usually have their own ideas regarding the amount of air to be supplied, although these are often only approximate.—*Foundry News.*

A locomotive on the Albuquerque division of the Santa Fe Railroad has run 232,894 miles without going to the shop for repairs.



OIL HEATER FOR COMPRESSED AIR.

OIL HEATER FOR COMPRESSED AIR

The efficiency obtained by re-heating compressed air is well understood. In re-heating, however, it is important to secure uniformity of temperature, and this is difficult to maintain when the heat is applied directly by passing the gases from the burning of fuel around coils or chambers through which the air circulates. The accompanying illustration shows a most efficient and economical heater, designed by Gerald Sherman, superintendent of the mining department of the Copper Queen Consolidated Co., at Bisbee, Arizona, and erected by him at the Holbrook shaft. In this heater a heavy oil is employed as a medium to transmit heat to the air-pipes, which latter pass through the oil-container. This oil is a residue from the partial distillation of the lighter compounds from crude petroleum, the residue having a gravity of about 12 degrees Beaumé, and a flash-point of 700. The heater consists of a boiler 7 ft. 6 in. long by 4 ft. diam., provided with a dome which is open to the atmosphere. An 8-in. air-pipe admits the compressed air to a chamber at the rear lower side of the boiler, from which it is conducted through 1-in. tubes which make two turns within the boiler, causing the air to travel three times the length of the container in contact with the oil. One large flue, 10 in. diam., also passes through the lower part of the boiler for the heated gases. The boiler is set in brick-work in the ordinary way, the grate extending the full length from front to back. On this grate a coke fire is maintained, which raises the temperature of the oil to about 335 degrees F., although it can be brought to 360 degrees. Coke at Bisbee costs $10 per ton, and the amount consumed in re-heating the air does not exceed 400 lb. per day. The temperature of the air as delivered to the hoisting engine is usually about 315 degrees F., and the temperature of the exhaust is from 32 to 40 degrees. In a 27-minute test the consumption of free air per shaft horse-power was 24.4 cu. ft. Another test of 40 minutes' duration with air at a temperature of 355 degrees showed a consumption of 28.7 cu. ft. of free air per shaft horse-power. The total work done in this test was 58,441,980 foot pounds, or a total shaft horse-power of 1771. Approximately 75 lb. of steam at the power-house equalled one shaft horse-power at the hoist. In this test the weight hoisted was weighed, and allowance was made for rope-friction and all loses. These re-heaters are being installed at the several subsidiary shafts of the Copper Queen, and hoisting by air will be used exclusively. It is found that the economy is greater than by transmitting electric current for this purpose.—*Mining and Scientific Press.*

THE ISOTHERNAL STRATUM AND THE COLDEST REGION OF THE UPPER ATMOSPHERE

A report has recently been published giving the results of the remarkable series of sounding-balloon ascensions executed in equatorial Africa by the expedition under Beson and Elias sent out by the Royal Observatory of Lindenberg. Among the interesting data given perhaps the most important are those relating to the temperatures of the upper air.

It may be said to be known by all mankind that the temperature of the air decreases thermometrically as the altitude increases, as exemplified by the familiar fact that the top of a mountain is colder than the base, although apparently occasional inversions of this may occur, as when fruit trees are frost-bitten in a valley while those on the adjacent hilltops escape. Other considerations apply, however, in the explanation of this latter phenomenon.

Until Teisserenc de Bort announced his discovery of the isothermal layer, eight years ago, it was not suspected that this decrease of temperature did not extend upward to the limits of the atmosphere. Now, however, we know that at a certain altitude, averaging, in middle latitudes, about 11,000 meters (7 miles), the fall in temperature with increasing altitude ceases rather abruptly, usually giving place to a *rise* of temperature for a certain distance upward, above which the temperature remains approximately constant as far as the highest ascents of sounding balloons have carried thermometric apparatus.

Hence, above any given spot on the earth's surface the air is coldest just below the region of the upper inversion, which marks the beginning of the great isothermal layer (or, as it is now called by its discoverer, the *stratosphere*).

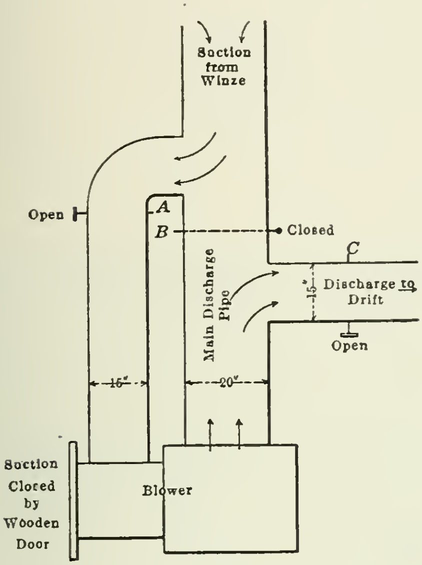
The altitude of the isothermal layer varies with the barometric pressure at the earth's surface, with the season, and especially with the latitude. It is somewhat less over the poles than over middle latitudes, and very much greater over equatorial regions than anywhere else in the world. In other words, the decrease of temperature with altitude continues to a much greater height within the tropic than elsewhere, and this explains the fact that the lowest temperature ever registered in the atmosphere was met with almost exactly over the equator, viz.,—84.3 deg. C. (—119.7 deg. F.). at an altitude of 19,300 meters (about 12 miles), at Shirati, on Victoria Nyanza, August 30th, 1908.

A NEW PROCESS FOR THE FIXATION OF ATMOSPHERIC NITROGEN

Atmospheric air is a mechanical mixture (as distinguished from a chemical compound) of oxygen and nitrogen gases—that is, the nitrogen in the air is in elementary form, mixed, but not combined with other elements. The importance of the problem of the "fixation" of atmospheric nitrogen rests in the fact that elementary nitrogen, as contained in the air, is inert and practically useless, while nitrogen compounds are of great commercial and industrial value, especially in the fertilizer industry. The object of the fixation of atmospheric nitrogen is simply to change the elementary nitrogen of the air into a useful nitrogen compound.

Since there are various useful nitrogen compounds there are various fixation processes possible. The simplest in idea is to take the oxygen and nitrogen in the air, as it is, and to try and combine as large a portion of them as possible directly into nitrogen oxides (to "burn the atmospheric nitrogen") and then work them up into nitric acid or nitrates. This can be done by subjecting atmospheric air to a very high temperature by means of electric arc discharges, as is done with commercial success in Norway in the process of Birkeland & Eyde and in the Schoenherr process of the Badische Company. The disadvantages of this method are twofold: The first product of the reaction is a dilute mixture of nitrogen oxides in atmospheric air and its transformation into nitric acid is complicated and not inexpensive; and secondly, the electric power consumption is high and the process is commercially practical only in countries where electric power is exceptionally cheap and where there is little incentive to use the available cheap power for other purposes. Norway is the classical example of such countries.

Another useful nitrogen compound is calcium cyanamide, which may be used either directly as fertilizer or as starting material for the manufacture of other chemicals, like cyanide. In the manufacture of calcium cyanamide the air cannot be directly used, but it is first necessary to separate the nitrogen from the oxygen in the air (for instance, by fractional distillation of liquid air); the nitrogen is then made to react with calcium carbide at an elevated temperature, yielding directly cyanamide. The power consumption is not so high as in the nitric acid process mentioned above. Nevertheless, the production of calcium cyanamide, being based on calcium carbide manufacture, also requires comparatively cheap power.—*Metallurgical and Chemical Engineering.*



REVERSING AN AIR CURRENT

The sketch, here reproduced from The Engineering and Mining Journal, shows a simple piping arrangement for reversing the air current from a fan blower. The scheme is employed on the 2000-ft. level of the Union mine, at Virginia City, Nev., where a Sturtevant, multivane blower is used to supply air to a winze from which levels are being opened. The main discharge of this blower is 20 in. in diameter and the fan is run at 1120 r.p.m., being belt connected to a 20-h.p. motor. The power consumption is about 16 horsepower.

Ordinarily the fan is used merely to blow fresh air down the winze through the 20-in. main-discharge pipe. After blasting, it is, however, necessary to draw the foul air and gas from the winze. The 20-in. pipe then acts as a suction pipe, the air current being drawn (into the blower) through the parallel length of 15-in. pipe and discharged through the 20-in. pipe and connecting 15-in. pipe. A wooden door or gate is used to close the suction end of the blower and the gates *A*, *B* and *C* in the pipes control the air current. The sketch shows the blower drawing air from the winze and discharging it into the drift. After clearing out the winze the door is removed from the suction of the fan, valves *A* and *C* closed, *B* opened, and fresh air is blown into the winze.

It is much quicker and more economical to draw out bad air than to force it out by blowing in fresh air. In the winze mentioned, no time has to be lost between shifts even though the temperature of the air would quickly rise to above 120 deg. F. if artificial ventilation were not resorted to.

A NEW REFRIGERATING MACHINE

A new refrigerating machine has recently been exhibited in London of which we have as yet only a crude description. As described it consists of two closed copper cylindrical vessels mounted on a horizontal spindle. The spindle, being tubular, affords a passage between the vessels, which are revolved on a light framework by means of a crank handle. In operation, one of these cylinders, charged by the makers with a liquid of special composition, is heated by a flame, while the second is cooled by a spray of water, a slow rotary movement being given to both meantime. The heating causes vapour to pass from the liquid in the first cylinder into the second one, where it is condensed. The flame is then extinguished, and the second cylinder is covered with a water-tight hood, which is filled with water. This having been done, the water spray is directed on the first cylinder, and as it cools, owing to the vacuum which is formed, the liquid condensed in the second cylinder evaporates and passes into the first cylinder, where it is absorbed by a hygroscopic medium. The cooling produced by the evaporation in the second cylinder cools the water in the hood, and eventually causes it to freeze. It is claimed for the machine that no dangerous chemicals are employed; that the charge of freezing liquid does not lose its efficiency; and that, in regard to maintenance, the cost of the heating, which is effected by two methylated spirit lamps, is the only expense. At the demonstration about 10 lb. of ice was produced in slightly over an hour from the starting of the machine.

FOR HOUSE AND OFFICE COOLERS

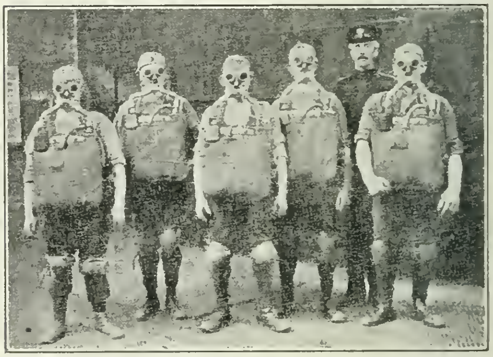
Among the favors conferred by a generous republic upon its valued servant, President Taft, is an office room that at this season of the year is artificially cooled, just as in Winter it is artificially heated. Not only is this doubtless very pleasing to the President, since what may be called his personal architecture is such as to make him feel more than some other people the discomforts of hot weather, but it is probably a profitable use of public money, since it will enable him to do more work and better by diverting his attention from the tropic fervors of a Washington Summer.

Now, when one comes to think of it, there is difficulty in understanding why humanity has always realized the need of mitigating the severity of climate that takes the form of cold, but for the most part still assumes the impossibility of doing anything to temper heat, from which we suffer almost as much. At less expense than that by which houses are warmed in Winter they can be cooled in Summer, and, while the Winter heating, thanks to our strange refusal to learn the art of ventilation, involves the creation of conditions injurious to health, those which Summer cooling would establish would probably be in every way beneficial to us. At any rate, the thing is perfectly practicable.

Of course, if adopted, it would add to the cost of living, but it would also increase the general stock of available energy, which would mean an increase of earning power to a more than compensating degree. Not much of a refrigeration plant would be required to bring the air of a bedroom to a temperature in which sleep would be refreshing, instead of impossible or exhausting, and the wonder is that the rich and the well to do, at least, do not generally, instead of hardly at all, utilize a benefit which science is ready to give them for much less money than they pay for a thousand other smaller luxuries and conveniences.—*N. Y. Times.*

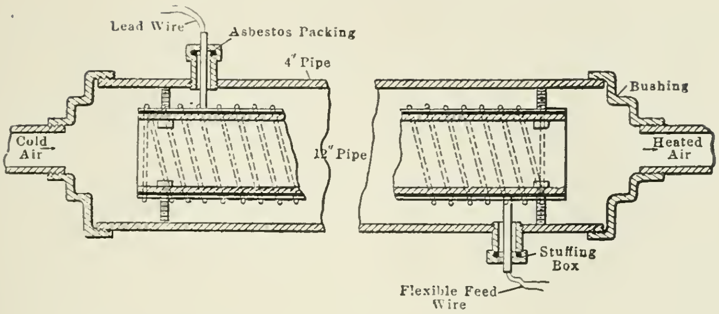
ARTESIAN WATER PREDICTIONS

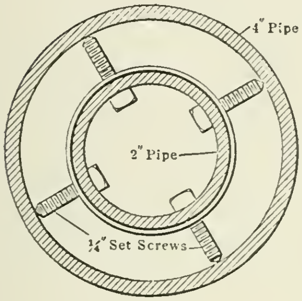
An excellent example of the utility of geologic predictions based on geologic knowledge is shown by the extensive investigation of underground water carried on by the U. S. Geological Survey, affording a basis for predicting flows in several areas, some of the predictions having been remarkably verified. At Edgemont, S. D., a well was sunk by the Burlington railroad company. Mr. N. H. Darton of the Survey was consulted and predicted that water could be expected in the Deadwood sandstone about 3,000 ft. below the surface. The boring was begun, but meeting with many difficulties and reverses, there was a disposition to abandon it. The engineers, however, had confidence in Mr. Darton's prediction and urged continuance, resulting in a great flow of water being struck at 2,695 ft. The well yields a half million of gallons a day of tepid water satisfactory for locomotives and other uses in a region where there is no water for 60 miles. Similar predictions have been verified along the extension of the Chicago, Milwaukee & St. Paul railroad and the Chicago & Northwestern.

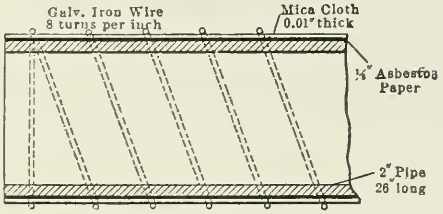


A LANCASHIRE COAL MINE RESCUE TEAM

The importance of having thoroughly trained rescue brigades among their workmen is generally recognized by British colliery proprietors and nowhere more so than in Lancashire, where the Federated Coal Owners some time ago built and equipped a commodious rescue station, at Howe Bridge, as a training ground. Here teams drawn from all parts of the Lancashire coalfields have been grounded in all branches of rescue work, interesting competitions having been arranged to test the capabilities of the different teams. The Earl of Ellesmere, who is the largest private coalowner in the County Palatine, has formed a rescue brigade of his own, drawn from his various pits. The striking little half tone shows a rescue tram with their instructor. Many workmen from his lordship's collieries have been trained at Howe Bridge, and could be relied upon to act in emergencies.







Detail of 2" Pipe

ELECTRIC COMPRESSED AIR REHEATERS

At the Bully Hill copper mines in Shasta county, Cal., a novel type of reheater is used in connection with pumps operated by compressed air. The arrangement is an electrical resistance coil inclosed in a pipe through which the compressed air passes directly before being utilized. The arrangement was worked out by H. A. Sutliffe, electrician for the Bully Hill Copper Mining and Smelting Company, and has proved thoroughly satisfactory.

The reheater consists of two principal parts, i. e., an outer jacket and an inner length of pipe upon which is wound the resistance wire. The air line is bushed to the pipe jacket and through this jacket are tapped, as shown in the drawing, two ½-in. holes provided with insulated stuffing boxes through which the flexible, lead wire is connected to the resistance coil.

In the design shown the resistance coil is wound on a section of 2-in. pipe, 26 in. long, the jacket pipe being 4 in. in diameter. The central pipe is first wrapped with 1-8-in. asbestos paper, and this in turn covered with mica cloth 0.01 in. thick. Over this is wrapped a helix of No. 14 galvanized-iron, telephone wire pitched eight turns to the inch. At points 1 in. from either end, the central pipe is tapped for set screws at four equally spaced points about its circumference. These set screws serve to keep the resistance coil from touching the outer pipe jacket. The wire coil is so wound as to not touch the set screws.

A reheater, as described, is designed for a 110-volt 40-amp. current and will use approximately 6 h. p., yet at the Bully Hill mine a saving of at least $6 per month has been effected, it is claimed, by each reheater installed. The reheaters are credited with raising the available air pressure 5 lb. [This statement is misleading. The effect of reheating in this case would be to increase the working *volume* of the air instead of the pressure, thus-reducing the volume required to be furnished by the compressor. Ed. C. A. M.]

With the electric reheater it is well to have the valve controlling the air engine, pump, etc., for which the air is being heated, connected with a pilot light, so that when the engine is shut off, attention will be called to that fact at once and the reheater will be disconnected. If this is not done there will be danger of burning out the reheaters as they soon become hot enough to destroy themselves if allowed to run after the air is cut off.—*Engineering and Mining Journal.*

ECONOMY OF THE PIECE WORK SYSTEM IN HANDLING SUPPLIES*

If we are going to get the largest possible output for the smallest cost, we must interest the man doing the work more than paying him by the hour. A man's interest must be vital if we are to get the best there is in him. We must pay for what we get, and not for what we do not. We must get 100 cents worth of work for every dollar paid out. This the piece work system accomplishes, as its organization and introduction shows.

At first blush it would seem to be a difficult matter to resolve the handling of supplies into given factors or units. This is not so, as we have a unit to issue or receive everything we handle in the store department, and a record to refer to that is permanent. Lumber is handled per thousand feet B. M. Iron, castings, coal, sand, etc., are handled by the ton. Pipe is handled by the foot. Mixed merchandise is handled by per package of 100 lbs. or less, over 100 lbs. to 200 lbs., etc. Filling requisitions and delivering material to the shops is handled by per item, per piece or per pound, depending upon the kind of material and the local conditions.

Filling requisitions and delivering material shows a very large saving put in piece work, due to the amount of lost motion that creeps in under the day work basis. Shop men will ask what has happened to the store men after they have been put on piece work, as they no longer stop to talk, but drop the material and hurry away for more. The men group their work, taking or getting all the material wanted from the different sections at one time. One foreman, planning the getting and placing of material, is only one part efficient as compared with a whole gang of four to eight men planning the same thing. In establishing piece work for a delivery gang composed of foreigners, who did not know the material and could not understand English, the prices were based on what was considered fair. The foreigners could not make one-half their day rate with the prices set, and were transferred. English speaking laborers were hired in their place, and they, being able to use their heads, made from 30 to 50 cts. per hour.

The men should be given to strictly understand that after a price is approved it will not be changed unless conditions are changed. They can make as much money as it is possible for them to make, and will be paid accordingly. As soon as the men are assured that they will be paid for what they do they will work their heads as well as their hands and feet, and will take advantage of everything possible. For instance, in one of our yards a derrick gang use long bridge bolts to handle 6-in. cast-iron pipe. These bolts are put in the end of the pipe to slip the sling around, enabling them to handle very quickly six to ten pieces at a time. These bolts are carried on the derrick to be used when needed. When loading a small order the men run ahead of the derrick with bolts and sling and load the pipe without stopping. It is impossible to get work done this way at an hourly rate, but there is money in this method for both the men and the company, as shown below:

Work done on hourly basis on which price was based:

Labor	$2.50
Use of derrick	2.00
Total	$4.50

Work done piece work in one-half the time:

Labor, P. W. rate	$2.00
Use of derrick	1.00
Total	$3.00

Saving, $1.50, of 33⅓ per cent.

We had four men in one of our lumber delivery gangs and the day we were about ready to start piece work one man quit, and the other three refused to work until another man was put in his place. The piece work system was explained to the three men, and they were asked if they would do the work on this basis, which they agreed to do. Soon after, one of the three left the service of the company, and the remaining two are handling this work, together with a large increase, in about 70 per cent. of their regular working time, making a high rate of pay. The company is saving one man's time and about 30 per cent. of three men's time on this particular work.

At one of the large icing stations, where an average of 100 cars per day are iced, and some days as many as 250 cars, it was necessary under the day work system to take a large force of men from one of the other departments to help during rush hours. However, since piece work has been installed the regular force has handled the work without delaying a single train or having a complaint from the shippers. The men know the more they hurry the more they make.

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*A paper by D. C. Curtis before the Railway Storekeepers' Association, St. Louis, Mo., May 16-18, 1910.

On one of the scrap docks it was impossible under the day work system to keep the pile of miscellaneous mixed scrap sorted and cleaned up as fast as it came in with the regular gang assigned to this work, it being necessary to put on additional help to prevent congestion. Ninety days after piece work was installed the regular gang cleaned up this scrap without additional help, and now take care of it and have time to do other work; yet a better foreman than the man in charge of this dock cannot be found.

It is impossible to work unintelligent foreign laborers to advantage. A gang cannot be divided, sending one man for a given article, another to the shop for manufactured material and have others sorting out material. The foreman has to take the whole gang with him, or have part idle, to get even a given size of bolt or article of any kind, as the thing wanted has to be pointed out and motions used to direct their movements.

With the piece work system we are able to hold the men after we have them educated. In May, 1908, a storekeeper hired 50 Austrians who had just come to this country, and they after becoming familiar with the conditions, were put on piece work. Thirty-five of the original 50 are still working for this storekeeper, one having died and the others leaving the service. The men are making good wages, and it is needless to say they are an efficient force. For increased and intelligent effort men make enough for the work to be attractive. The longer men stay, the more proficient they become, the more money they make, fewer mistakes and breakages occur, and discipline is easier.

Piece work keeps men and methods of doing work out of ruts, as the men are continually scheming short cuts and new kinks. It gives us machines and tools with which to handle work quickly. To show a saving in having machinery to handle material is a very simple problem in arithmetic when on a piece work basis; i. e., lumber handled by hand costs 5 cents to 85 cents per 1,000 ft., B. M.; with a derrick, 15 cents per 1,000 ft., B. M.

Piece work forces the storing of material in the most convenient places for handling. In one of the large new storehouses recently built the connecting rods for engines are kept in a closed rack in the center of the house, without lifts of any kind to handle them with. Piece work would very quickly show the saving to be made by putting these rods where they could be handled with a small crane at a great saving.

Piece work gives a contented set of men, each man in business for himself. Men would rather work piece work than day work, as is shown by the engine men and trainmen being paid by the mile, miners by the ton, etc. These men would not think of going back to the hourly unit. The rapid, intelligent workman receives wages in proportion to work done; ability is paid for.

A CONTRACTOR'S MELODRAMA

A contractor decided that he would write a play in which the hero would be a plain but honest contractor who would cop the girl and the wealth in the last act and live unhappily ever after. He wrote his play and has given us the privilege of giving a synopsis of it. This we have done for the purpose of showing that there are strong dramatic possibilities in the life of a contractor. The plot of the play, in brief, is as follows: Tom Jones, a young contractor, is in love with Mame Brown, daughter of Dunne Brown, president of the Hot Air Line. Brown awards Tom the contract for building a 100 mile railway, one of the conditions being that if the work is completed by 10 a. m., Nov. 15, Tom secures the daughter as a bonus; if the work is unfinished at that time Dunne Brown gets the road for nothing. Goodrich Mudd, 1st vice president of the road, is also in love with Mame but is spurned by her, as he already has two wives. He plots to foil Tom and is ably assisted by J. Little Work, 2d vice president of the road. Bill Smith, assistant chief engineer of the road, is a friend of Tom's and comes to his rescue at various critical moments. A summary of the four acts follows:

Act 1. Grading camp at night. Enter foreman, skinners, hoboes, waterboys, etc., singing, "It's 14 miles to the nearest drink, and you have to walk all the way." Supper; song, "What, beans again?" Mule skinners by light of banjo torches skin two mules that had died from fright at the sight of oats.

Act 2. Scene in Tom Jones's tent. Enter bill collectors for feed men, grocerymen, butchers, etc., etc. "I'm busted." Bill Smith: "Take this $10,000, my last month's pay." It begins to rain; it pours; high water; floods; tempest; hurricane. Glanders in the stock. Steam shovel busted. Concrete mixer blown-up. "There's deviltry in the air."

Act 3. Scene 1, headquarters of chief engineer. "We allow no rock in this estimate, it's all earth." "My God! it cost me $1.25 per cu. yd." Scene 2. Court. 56 experts on one side, 56 on the other. "The judge finds that this is rock and holds you to the terms of the contract."

Act 4. Site of bridge, 9.45 a. m., Nov. 15. Pile drivers, hoists, cableway from distant cliffs to bridge site, etc. Tom Jones discovered tied beneath hammer on ponderous pile driver. Goodrich Mudd and J. Little Work prepare to let hammer drop. Mame Brown and Bill Smith appear on distant cliff. "My God! We're too late." "Quick, the cableway bucket." Bang! Bang! Just in time. Ten minutes to finish the work. In with a pile. "Who'll run the engine?" "I, Mame Brown." "It's down. The railroad is completed. I've won my bonus."—*Engineering-Contracting.*

VACUUM FOUNDATIONS

"Vacuum" foundations—so miscalled—are being exploited in Germany. Under this arrangement foundations proper of masonry or timber, and also foundation bolts, it is claimed, may be dispensed with for machine tools, steam engines, air compressors, etc. The normally level floor—cement, wood, asphalt or what not—is used as it is, provided it is strong enough to bear the load. Between the machine and the floor there is laid a soft rubber plate or mat. The patentee claims a vacuum action, but this, on an average machine tool or steam engine, that has only a few planed strips on the under side of the base, would be hardly worth considering. It seems to be a fact, however, that steam engines and machine tools are running on such mats, without being secured to the floor, and this has not only the advantage of cheapness and rapidity of construction, but also that a machine may be readily moved and set running in a new place.

From the legal standpoint, also, machines thus set do not form part of the real estate, as they would if secured to a foundation. There is even a trifle less noise, and electric machines are insulated from ground contact. In the Imperial Exhibition for Improving the Conditions of Workmen, Frauenhoferstr, 12, Charlottenburg, several machines thus set have been on exhibition, running since March, 1907. In the Borsig Locomotive Works, Tegel, near Berlin, a 45-hp. horizontal reciprocating steam engine is running on such a mat, unbolted.

WASHING THE AIR

A reporter for a Chicago daily paper, in telling of a trip through the new Blackstone Hotel, writes as follows:

"Let us visit the air laundry," said the chief at length.

He opened a door, projected an electric lantern through the dark, and disclosed a splashing sheet of water. Through this Niagara air was being driven with tremendous force.

"Look below!" boomed Mr. Boomhower. "That pool contains the dirt which is removed from the incoming atmosphere *every minute.*"

All glanced at the inky water. Chief Steward Muller gasped. Mr. Tompkins whistled what must have been "the Air Washed Life Is the Life for Me!"

DRY AIR MEAT PRESERVING

Some experiments have been made in Sydney, Australia with a "dry-air process" of preserving meat, which seems to promise auspicious results. Some of this meat after being treated by the new process has been hung up in bags, and then after about 15 days opened in the presence of veterinary surgeons and commercial men and found quite fresh. The inventor of this "dry-air process" claims that for $100 a station owner can put up the necessary plant and treat sheep at a cost of one cent per carcass, and after being treated by this new process the meat may be hung in any ordinary place and atmosphere and kept good for a week. The period of treatment is about 14 hours. Some of this meat, according to the Herald, of Taranaki, New Zealand, from cattle and sheep killed at Sydney between December 7 and 14, arrived in Wellington, New Zealand, on the 22d, having been carried in the ordinary vegetable hatch on the deck of the vessel, and when examined by the press representatives was quite sweet and sound.—*Consular Reports.*

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. AUGUST, 1910. No. 8

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COMBUSTION AND EXPLOSION

The fatal explosions in coal mines, which seem to be little nearer to reliable control and complete prevention than half a century ago, are compelling special investigation at the present time with some hope of ultimately attaining greater safety. When we begin our investigations of these explosions we naturally first of all wish to know what are the conditions and what the sequence of events in the case of an explosion, or what, in fact, an explosion really is.

If there be any precise point of demarcation between the familiar action of combustion or burning, as of a candle or of an ordinary wood or coal fire in grate or stove, and that of explosions so-called, whether explosions of the common explosives, as gunpowder or dynamite, of explosive mixtures of comminuted hydro-carbons and atmospheric air, as in the gas or oil engine, of mixtures of air and inflammable gases in coal mines, or explosions of mixtures with air of finely powdered combustible material, as wheat flour, fine sawdust or coal dust, we do not know where that point is located.

Indeed, a tolerably clear understanding of the entire series of phenomena may be arrived at by regarding them all as of the same class, the only element of difference being in the time consumed by the specific event. An explosion we may regard as a rapid fire, and an ordinary fire we may call a slow explosion. There is nothing instantaneous, or without the expiration of time, but a sequence of causes and effects in each case, the one demonstrably preceding the other.

For combustion in general we must have some so-called combustible material, something having an active affinity for oxygen, and we must have the oxygen, usually as contained in atmospheric air, these to be in intimate contact or capable of such contact, when they will be ready for the burning, which however, will not begin until a sufficiently high temperature is produced, although after combustion begins the temperature is usually self sustained or augmented.

In the act of combustion the combustible and the oxygen unite in certain definite proportions, so much combustible to so much oxygen and vice versa. In the burning of a solid this proportion is self maintaining, as the burning is upon the exterior surface of the solid combustible and proceeds slowly or rapidly according to the access of the oxygen.

When combustible gases and atmospheric air are intimately mixed, the oxygen present being just sufficient in quantity for the amount of combustible, then we have a so-called explosive mixture, which is ready for complete combustion throughout its entire mass if it can be raised to the temperature required for ignition. Combustible solids if ground to fine powder and then mixed with the proper proportion of air form explosive mixtures whose combustion occurs apparently in the same manner and with the same results as with the strictly gaseous mixtures. Dust of any readily burning material seems to be capable of combining with air to form an explosive if fine enough and intimately mixed in the right proportions. Wheat flour, sawdust, and frequently coal dust, have been the agents of disastrous explosions.

Professor Paul Spier, of Breslau, tells us of an explosion of a mill in which zinc dust was being sifted for market, the dust in the air providing the combustible element of the explosive mixture. This should not be at all surprising to any one who has ever melted zinc in an open ladle. The melting point of zinc is only slightly above that of lead, and yet the zinc takes fire as soon as it begins to melt, and if the surface of the metal is not protected much is wasted by the burning. The ready combustibility of the zinc thus cannot be questioned, and the dust of it when mixed with its due proportion of air would be fired, we may assume, by a spark or other means giving a firing temperature no higher than that required for firing the coal dust mixture.

The proportion of coal dust in air to constitute an explosive mixture has been quite definitely determined. At the Lievin station, in France, the lowest density at which ignition was invariably produced was 70 grams (1,080 grains) of dust per cubic meter (35.315 cubic feet), and below a density of 46 grams (710 grains) per cubic meter only negative results could be obtained. An experiment by Galloway has shown that 1 pound of average coal dust will render explosive 160 cubic feet of air. More exhaustive data along this line are being accumlated at the Pittsburg testing station.

We have intimated that the essential difference between ordinary combustion or burning and explosion is in the time occupied. That is in the event as a whole. In the details of the explosion operation an important element enters which in a sense annihilates time, this being in the initial pressure generated. At the point where the mixture is first fired the volume of the constituents is greatly increased, and this local increase of volume results in a sudden increase of pressure throughout the mass, this increase of pressure being accompanied—not followed—by a corresponding rise of temperature, the rise of temperature extending to and above the ignition point, and then the entire mass is fired, or, as we might say, it fires itself all through and all at once, and this we call an explosion.

THE COAL MACHINE PROBLEM

The advent of machinery in any line of industry is likely to transform its methods and to change its products or results more or less. The work and the workers make concessions and accommodate themselves to the ways of the machine to secure its advantages. The rock drill, for instance, has radically changed the planning and the working of the world's great engineers. From before the time of the Romans down to the building of the first Croton aqueduct water was conducted in open channels, with just enough descent to permit an easy flow; and to secure the necessary level the line meandered tortuously along the edges of the hills, and costly works were required to cross the valleys and the streams.

Now the rock drill makes the pressure tunnel possible and cheap, and it is driven by straight lines from point to point. In this respect the coal machine is more or less an anomaly, in that it gets so few and small concessions from the work it undertakes to do. Mining conditions can be but little changed to accommodate the machines, and it is the machines which must be adapted to the conditions. The coal mining machine undertakes to supersede the hand-work pick, and it must work in just the same situations in which the hand pick has been worked. Generally, too, the man who has worked the pick, perhaps for years, becomes the manipulator of the machine when it is introduced. It is, of course, at all times largely dependent upon the skill and judgment of the man who handles it, and as the hand pick is of widely different effectiveness in different hands, so the machine makes different showing, according as it is handled.

As the conditions of coal mining vary so much, especially as to thickness and pitch of the seam and the hardness of the coal, it is not to be expected that any one style or size of machine will be universally suitable, and we might even expect ultimately a wider series than yet exists. The coal machine may, in the long run, expect fair play, and will win upon its merits.

From official notes upon coal mining machines, so far as they have been fairly tried, the following claims have been made for them: There is an increase in the proportion of lump coal produced, a greater yield per acre, reduced working cost, reduction in the amount of explosives required, reduced cost for timbering, and fewer roof falls; larger daily wage for the collier, while relieving him from the most laborious and dangerous work.

Coal-cutting machines, so-called, are not new, having been tried in Great Britain more than half a century ago, but with so little success or encouragement that, so late as 1902, there were only 166 machines in use. In 1907, however, there were 1,493 machines.

With regard to coal machines in the United States, there are some interesting figures, but not very closely up-to-date. The number of machines in use increased from 7,663 in 1904, to 9,184 in 1905, and to 10,212 in 1906, 5,911, or 58 per cent., of this number being of the pick or puncher type. The percentage of increase in the production of machine-mined coal in 1905 over 1904 was greater than the percentage of increase in the total production. In 1906 the quantity of machine-mined coal was 15,451,075 short tons greater than in 1905, while the total production of bituminous coal increased 21,534,643 tons, showing that 72 per cent. of the increase was in the machine-mined product. The average output for each machine in use increased from 10,258 tons in 1904 to 11,258 tons in 1905, and to 11,638 tons in 1906. The percentage of machine-mined coal to the total production in 1899 was 23; in 1900, it was 25.15; in 1901, 25.68; in 1902, 27.09; in 1903, 28.18; in 1904, 28.78; in 1905, 33.69; and in 1906 it was 35.10.

A new height record for aeroplanes was made by W. H. Brookins at Indianapolis when with a Wright biplane he reached an altitude of 4,503 feet. His engine gave out and he made a sensational glide to the ground.

COMPRESSED AIR IN VENTILATING

The practice of turning compressed air into a ventilating pipe to induce an air current is said to be common in the Coeur d'Alene mines. This is quite a simple and inexpensive method of ventilating drifts when compressed air is at hand and power to operate a fan blower is not available. On the 1,200-foot level of the Hecla mine at Burke air is drawn in this manner 500 feet from the face of a drift to the shaft. Twelve-inch pipe is used, and a piece of ¾-inch pipe turned up at the end serves as the air nozzle. The air current is in this instance sucked 500 feet through the fan pipe, the air-jet being introduced into the fan-pipe about 15 feet above the bend at the shaft.

A different scheme is used on the 1,600-foot level of the Mace mine. Here the air-jet is applied within a few feet of the suction end of the fan-pipe. In this manner a current of air is forced 400 feet to the shaft through an eight-foot fan-pipe. The nozzle in this case is made of one-half-inch pipe bent in circular shape to fit around the interior of the fan-pipe. The coil is drilled with a number of one-eighth inch holes on the side opposite the suction end of the fan pipe. It is claimed that this acts as a more efficient nozzle, and requires much less air than does turning in the air in a single jet. These nozzles may be used at a number of places in the fan-pipe if one will not draw a current of air sufficient for proper ventilation.

THE OLDEST COLLIERY LEASE

The following, believed to be the earliest known colliery lease or agreement, was recently published as an appendix to the presidential address of Dr. J. B. Simpson before the Institution of Mining Engineers:

"Thys indenture made betwix William the Priour of Duresme of that part and John Brown of Tudhowe, Bertrame Gaytherd, Alexander Belfielde, William Litham, Rollyn Drensmyth of Middleham, and William Brown of Duresme flesshewer on that part, witnesse that the said Priour has granted and to farm lettyne to the said John, Bertrame, Alexander, William, Rollyn and William a wast tofte and 28 acres of land with the appurtenances in Trillesden and with a colepit in the same lande therein to work and *wyn cole* every day overable with thre pikkes and ilk pike to wyn every day overable 60 scopes. To have and to holde the said toft and land with the appurtenantes and with the said colepit fra the feast of Seynt Cuthbert in Septembre next commyng for term of a yeer then next following; givyng to the said Priour for the said tofte and land with the appurtenances 24 *s.* and for the said colepit 10 marke of goode Inglish money at the feists of the Invencion of the holy croce and the nativite of Seinte John Baptiste rent commyng be even porcions. And the said John, Bertrame, Alexander, William, Rollyn and William sall werke the said myne werkmanlike, to save the feld standyng be the sight of certeyn vewers assigned be the said Priour ats oft as hym likes to lymet them within the same year to serche the same myn. In the witness of the whilke the partyes aforesaide has entrechangeably to this indenture sett their seales. Wreten the last day of August the yeer of our sovereign and gracious Lordo Jesus MCCCCXLVII. (1447)."

AIR CONSUMPTION OF ROCK DRILLS

"The rating of air compressors when expressed in the number of rock-drills to which they are capable of supplying air, is usually based upon a consumption of a volume of air at 60 lb. per square inch pressure, equivalent to about 100 to 110 cu. ft. of free air per *second*."

This interesting paragraph seems to have been made by one of our technical contemporaries for a filler at the bottom of a column, but we find it reproduced verbatim by another most esteemed and usually most reliable exchange. It of course should be a minute instead of a second, and at least 80 pounds gage pressure should be suggested instead of 60, while the diameter of the drill cylinder should be mentioned as one of the necessary factors. Thus the above volume of free air should on the average be sufficient for a 3-inch drill, while for 10 drills of the same diameter not more than three-quarters of this per drill would be required, as all the drills on a job never work all the time or all together.

KEEP DYNAMITE DRY

Dynamite should never be stored in tunnels, nor in any place where dampness exists. Although a tunnel may seem dry, all rock-in-place contains from 3 to 8 per cent. of moisture, which is continually being brought to the wall surface in underground workings by capillarity, where it is evaporated unless, for want of ventilation, the air is saturated. Thus the rock is continually contributing moisture, which is greedily absorbed by the sodium nitrate in the dynamite, that salt being highly hygroscopic. As soon as the sodium nitrate has deliquesced, that is, melted from absorption of moisture, the homogeneity of the dynamite becomes disturbed and the "dope" fails to retain the nitroglycerine, which then leaks out. The water substance often seen on cartridge paper, and the oily stain seen in dynamite boxes, is due to the leaking of the nitro-glycerine. A cartridge in this condition is far more liable to accidental explosion than sound dynamite, and it is perilous and uneconomical in use. It will not develop the same energy as good dynamite; it is likely to burn and blow out instead of detonating properly, and it is a frequent cause of "mis-fires," and of the failure of a charge to explode to the bottom of a hole. Dynamite must be stored in a dry place. —*Mining Science.*

REHEATING COMPRESSED AIR WITH STEAM

The practice of reheating compressed air by mixing it with steam is employed generally in the Cœur d'Alene mines of the Federal Mining and Smelting Company. Results obtained at these mines seem to indicate that this is the most economical and efficient method of getting the full measure of energy from the air.

At the Mace mines, air at 90-lb. pressure for drills, and steam for the hoist were formerly conducted the 3000 ft. through the entry tunnel in separate pipe lines. The air is now compressed to 100 lb., mixed with superheated steam at the compressor house and piped into the mine in one line to supply both hoist and machine drills. The daily saving by this arrangement is figured at about $40, and, besides, an increase of 10 lb. in pressure is gained for drills. The steam plant formerly required 14 tons of coal per day, while from six to eight tons is all that is burned now. The boiler at this plant is rated at 80 h.p. and the capacity of the compressor is 4000 cu. ft. of free air per min. No trouble has been experienced from either freezing or condensation.

At the Morning mine the boiler for generating steam for reheating air will be situated at the underground hoisting station. The shaft will have four compartments and through it 1000 tons of rock per 24 hours will be hoisted.

The engine and drills will be run on a mixture of compressed air and steam.—*Eng. and Min. Journal.*

A PUNCTURELESS AUTOMOBILE TIRE

What is claimed to be a punctureless automobile tire has made its appearance in England. It comprises an inextensible heavy canvas lining, the crown being packed with a puncture-proof material and placed between the outer cover and the inner air tube of the ordinary pneumatic tire. The lining is so made as to cause a low pressure on the tread and to more nearly equalize the pressure on the inner air tube. The lining is thickest at the crown and tapers to a feather edge near the rim. The external appearance is like the ordinary tire. The inventor has given it drastic tests. He made several gashes and cuts on the outer cover of a tire through to the patent lining, and with these has driven his car 500 miles without a puncture or the necessity of repair on this tire, although wheels on the same machine fitted with other tires had the usual difficulties. Other tests on heavy cars without the special gashes have been equally satisfactory. An inspection of the invention impresses one with its simplicity, and the carved outer cover used and seen demonstrates that it is a great development in tires for use on automobiles.

A NEW GAS FOR BALLOONS

A new German invention of value for non-dirigible balloons is reported by Consul Thomas H. Norton, of Chemnitz:

Illuminating gas is forced through long tubes, maintained at a very high temperature. Most of the carbon in the hydrocarbons is thus separated out and the percentage of hydrogen is largely increased, so that this gas constitutes 80 per cent. of the modified coal gas. At the same time it is deprived almost entirely of its characteristic odor, and freed from the presence of benzine, which exerts an undesirable solvent action upon the materials employed to render balloons impermeable. The most important change is that in buoyancy, as the specific gravity sinks from 0.44 to 0.225, or less than one-quarter the weight of air. This means that 1 cubic meter of the new gas can support a weight of 1 kilo (2.2 pounds). In coal gas, 1 cubic meter supports 0.7 kilo. A balloon with a capacity of 7,000 cubic feet, when inflated with the new gas, has a lifting power equal to that of a balloon of 10,000 cubic feet charged with ordinary coal gas.

NEW USE FOR SMALL HAMMER DRILLS

Small hammer drills are used with a chisel bit in the Hecla mine at Burke, Ida., for cutting off the crushed ends of timbers. In the stopes the greatest pressure is from the squeeze of the walls, and as the ends of the stulls and caps become splintered and crushed, it is necessary to cut them off and put in new blocking. It is often difficult to get at the crushed timbers, and, even when accessible, it is not an easy job to chisel or saw the wet and twisted fibers by hand. The cutting of the wood is rendered quite easy with the drills, and by using sufficiently long bits, almost any desired place can be reached. The drills and chisels may also be used to great advantage for chiseling wall plates when an extra shaft compartment must be added, or in cutting off posts to ease up drift sets in heavy ground. In a number of mines, the blocking on drift caps is shot out when it is necessary to ease up on the sets; this work can much more safely and surely be accomplished with the drill.—*Eng. and Mining Journal.*

CHLOROFORMING AN AIR LEAK

An engineer in charge of an extensive plant found that there was an air-leak in some new piping which had been placed as an extension of an existing sprinkler system. It was of the dry type with compressed air filling the pipes to hold back the water. The pipes were charged with compressed air at 85 lb., and after two days the pressure had fallen to 35 lb., which should not have happened for six weeks or two months. Soap lather applied to the outside of the joint failed to locate the leak, and the resourceful engineer said "We'll chloroform the pipe and catch it napping." He got 3 oz. of ether and poured it gradually into the suction of the compressor as it pumped the pressure up again to the required 85 lb. Foremen of the departments were asked to watch for the odor of ether and to report it to the engineer. For the first day nothing was reported, but on the second afternoon the leak was etherized and located at once in a joint of the old piping close to the new addition, caused probably by abnormal strain when making the connection.

AN IMPROVISED AIR CUSHION

When some mine pumps delivering 1,200 gallons per minute against a head of 1,000 feet were first started considerable difficulty was experienced in obtainng quickly a sufficient air cushion in the air vessel of the discharge to prevent an annoying hammer. A remedy was found in an air-charging device. A length of extra heavy pipe, with blind flanges on each end, was placed alongside the pump. Connections were made from the air vessel to the pipe, and also from the column pipe and the air line in the mine. A drain was placed in the lower end of the pipe. To use this device, all connections are at first closed, except that to the air line, which charges the pipe with air at a pressure of 90 pounds to 100 pounds. The air connection is then closed, and that to the water column opened. This allows the pressure of the water in the column to compress the air. The column connection is next closed, and that to the air vessel opened. After charging the air vessel the pipe is drained of water, and the operation can then be repeated.

A COMBINATION AEROPLANE

Trials have been made in Berlin of an interesting machine invented by a German aviator named Grawert and designed to be used either as an automobile, a motor boat or an aeroplane. It is a combination of biplane and monoplane, and is equipped with a 50 horsepower Anzani engine, which is to propel the machine, with four passengers at the rate of 100 to 120 kiloms. (62 to 76 miles) per hour. To convert the flying machine into an automobile, the carrying planes are unfastened and then fixed to the body of the machine, so as to form the side walls of the automobile. The process of reconverting the flying machine into an automobile is calculated to take 30 minutes. During the trials on the uneven ground of the Tempelhofer Feld appreciated speeds were reached with four passengers in the chassis. An air propeller is used whether the machine is on land or water or in the air. For a machine of this type the word "amphibious" must be extended to apply to the third element.

NOTES

Contracts have been let for supplying dynamite to be used on the Panama Canal for the fiscal year 1911, the aggregate amounting to nearly 7,000 tons at a total cost of $1,658,000.

The Nelson (B. C.) Iron Works has taken over the business and stock of the Rossland Engineering Works, and will succeed that company as British Columbia agents for the Sullivan Machinery Company of Chicago.

In 1909, at the Ready Bullion mine, Alaska, 268,904 ft. of machine-drill holes broke 315,941 tons of rock, an average of 1.17 tons per foot of hole. The 700-Foot Claim mine broke 261,737 tons with 263,804 ft. of holes, an average of 0.99 ton per foot.

There were recently shipped to Paris six approximately cubical blocks of Indiana limestone having an average weight of 35 tons. The blocks go to the studio of a famous sculptor and after being carved into statues are to be returned to the United States to adorn the residence of a private citizen at Newport.

A coal dust burner using a jet of compressed air instead of a fan blast has been in successful operation for the past two years in a southern cement factory. Air at high pressure passes through a Koerting ejector nozzle and enters the kiln through a horizontal pipe. A vertical fuel supply pipe opens into the horizontal pipe just beyond the discharge end of the nozzle and between the nozzle and the kiln, the rapidly moving air jet carrying the coal dust into the furnace.

The British government has placed a submarine bell off the Lizard. It is suspended from a heavy tripod, which was lowered to the bed of the ocean at a point about two miles from land. The bell is connected by cable with the lighthouse, from which it will be operated. It is anticipated that, since steamers passing up the Channel all approach the Lizard, the bell will be of great assistance to them, particularly in time of fog.

A new kind of so-called Greek fire has been invented by a German officer. It differs from the old Greek fire in that it is not employed in the incendiary shells by which ships were once upon a time destroyed, but is poured out on the water and directed against hostile vessels. The fluid which occasions this fire, and the composition of which will not be disclosed, is of such a kind that it floats on the water, and it is impossible to extinguish the flames.

A careful investigation is being made of the iron resources of Brazil. Reports from the various districts show the extent of the known deposits to be of such great magnitude that the ore in sight is sufficient to supply the world's demands for centuries to come. The government of Brazil has recently appointed a special commissioner to investigate the steel industry of the United States and to make arrangements for the exportation of the iron ores.

A recent earthquake in California, which caused little remark at the time of its occurrence, is said to have increased the water supply of the city of Corona, in that State. The Temescal Water Company secures its supply from the Coldwater, Mayhew and Gregory canyons. During the entire year the flow varies but slightly, but since the quake the total increase for the three canyons amounts to 75 inches. As water sells for $1,000 an inch, this increase is worth $75,000.

Of the 5,000,000 horse power theoretically available at Niagara Falls only 270,000 horse power, or 5.4 per cent. has thus far been utilized. Of this 126,000 horse power is employed in electro-chemical processes, 56,000 horse-power for railway service, 36,400 horse-power for lighting, and 45,500 horse-power for various industrial services. Nearly 125,000 horse-power is transmitted to points more than ten miles from the falls. Of this amount 12,300 horse-power is transmitted over a distance of more than 100 miles, while 33,500 horse-power is transmitted between 75 and 100 miles.

The fixation of atmospheric nitrogen by an entirely novel process is announced by Prof. Fritz Haber and Dr. R. Le Rossignal, Karlsruhe Institute of Technology. The process, it is reported, has already passed from the merely laboratory stage and is being developed by the Badische Analin und Soda Fabrik. The new process is the synthesis of ammonia (NH_3) from nitrogen and hydrogen under a pressure of 200 atmospheres and in the presence of a catalytic agent like osmium or uranium. High temperatures are avoided. The hydrogen is produced by any chemical process found desirable and the nitrogen is used as in the air.

Ozonized air is now used as an adjunct to ventilation in the Chicago Public Library, and it is claimed that among other beneficial effects it has completely freed the reading room from the obnoxious human odor which has been noticed for years. The air to be passed through the ozonizer is first washed. The ozone generator is installed in a large air duct in such a way that all the air is forced between the electrodes across which a potential of 7000 volts is maintained. The energy required for treating the air is said to be 660 watt-hours for 10,000 cu. ft. of air. The plant was installed by the National Air Filter Co., of Chicago.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JUNE 7.

960.275. RATE-INDICATING DEVICE FOR FLUIDS. Frederick N. Connet, Providence, R. I.

960,361. ELECTROPNEUMATIC AIR-BRAKE SYSTEM. George Macloskie, Schenectady, N. Y.

960,478. AIR-COMPRESSOR. David R. Allard, Arleta, Oreg.

In an air compressor, a casing provided wlth a series of cells, each of said cells having an open end directly facing a body of water and being provided with a rear portion above the level of the front portion, all of said cells being arranged to be subjected to the waves of said body of water, air pipes connecting said air cells with a common air tank, valves in said pipes for retaining the air in said air tank, and other valves for permitting the entrance of air into said cells.

960.455. MOLDING-MACHINE. Peter Frederick Walstrom, Birmingham, Ala.

960,531. PNEUMATIC-DESPATCH-TUBE APPARATUS. Edmond A. Fordyce, Boston, Mass.

960.539. AIRSHIP. Robert E. Green, New York, N. Y.

960,557. FRONT HEAD FOR DRILLING-MACHINES. Grant Kemmerling, Douglas Island, Alaska.

960,564. PNEUMATIC CLEANER. Elmyr A. Laughlin, Chicago, Ill.

960,579. PNEUMATIC VEHICLE-GEAR. Louis J. Perkins, Lewiston, Idaho.

960,609. VACUUM-PUMP. George S. Williams, Norfolk, Va.

960,610. POWER-PNEUMATIC. George S. Williams, Norfolk, Va.

960,633. BAROVACUUMMETER. Gustav Frerichs, Hanover, Germany.

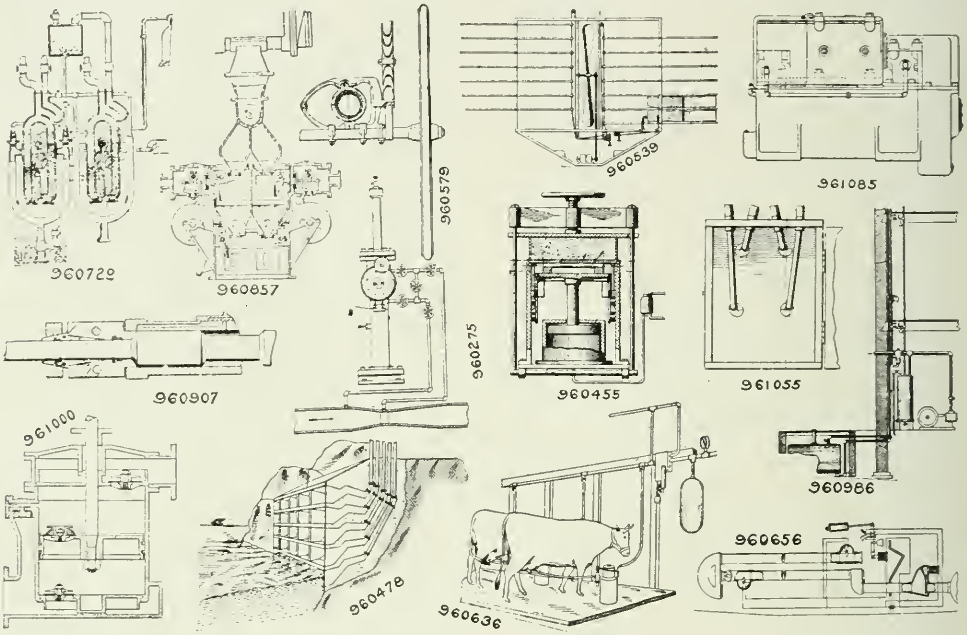
960,636. PULSATING DEVICE FOR MILKING APPARATUS. Ezra E. Good, Waterloo, Iowa.

960,656. PNEUMATIC-DESPATCH-TUBE APPARATUS. James Gayton Maclaren, Weehawken, N. J.

960,729. COMPOUND LIQUID-PISTON AIR COMPRESSING AND PUMPING APPARATUS. James K. Sweeny, Pueblo, Colo.

960,830. AIR-CONDITIONING APPARATUS. Stuart W. Cramer and William B. Hodge, Charlotte, N. C.

960,857. DISCHARGE MECHANISM FOR VACUUM-TANKS. William H. Eggert, Buffalo, N. Y.



Pneumatic Patents, June 7.

960,986. AIR-CONTROLLED FEED SYSTEM FOR LIQUIDS. Edward J. Moore, Cleveland, Ohio.

961,000. AIR-PUMP FOR USE WITH CONDENSERS AND THE LIKE. Philip Francis Oddie, London, Eng.

961,055. PNEUMATIC ANNUNCIATOR AND INDICATOR. Clarence B. Withrow, Denver, Colo.

961,085. MOTOR-COMPRESSOR. William H. Lieber, Milwaukee, Wis.

JUNE 14.

961,104. MEANS FOR AUTOMATICALLY INFLATING PNEUMATIC TIRES. Roger Connell, Westport, New Zealand.

961,144. COMPOSITION OF MATTER FOR REPAIR OF PNEUMATIC TIRES. John H. Lewis, Joplin, Mo.

2. The herein-described composition of matter for the treatment of pneumatic tires to prevent the escape of air when punctured consisting of ribbon glue 39 pounds, water 1½ gallons, molasses 1 gallon and 1 pint, linseed oil 5 pints, chrome alum 5 oz. 100 gr., bichromate potash 4 oz. 330 gr., water sufficient to make 25 ounces, substantially as described.

961,208. AIR-PURIFYING APPARATUS. George Clements and James M. Hostler, Chicago, Ill.

961,231. AIR MATTRESS, SEAT, AND THE LIKE. Nehemiah C. Hinsdale, Marion, Ind.

961,271. WINDMILL. Alfred M. Vold, Chicago, Ill.

961,306. APPARATUS FOR THE PROPULSION OF SHIPS. Charles Robert Mayhall, Arroyo Grande, Cal.

A vessel provided with compressed air tank, a pipe extending longitudinally from end to end of the vessel and discharging through the center of opposite ends thereof below the water line, valves arranged near the ends of said pipe, laterally extending pipes arranged near the front end of the vessel and opening through the opposite side walls thereof at points diametrically opposite, and similar pipes arranged at the rear end of the vessel, said lateral pipes having valves arranged therein, means for communication between the first-mentioned pipe and compressed air tank and steam pipes extending longitudinally through the tank to heat and expand the compressed air therein in order to increase the pressure thereof.

961,307. PNEUMATIC SPINDLE. Reuben H. Morre, Jeffersonville, Ind.

961,310. MEANS FOR OPERATING RAILWAY-BRAKES. Spencer G. Neal and Joseph M. Childress, Los Angeles, Cal.

961,317. HIGH-PRESSURE COMPRESSOR OR OTHER POWER-ABSORBING MACHINE. Auguste C. E. Rateau, Paris, France.

961,320. AIR-BRAKING APPARATUS FOR RAILWAYS. William H. Sheasby and Spencer G. Neal, Los Angeles, Cal.

961,364. BLOWER-UNLOADING DEVICE. James G. Maclaren, Weehawken, N. J.

961,365. HANDLE FOR MASSAGE APPARATUS. Thomas A. McCall and Charles M. Siebert, Jr., Columbus, Ohio.

1. A handle for massage apparatus made up of sections fitted together and provided with suitable filtering means, said handle being adapted to communicate with a vacuum pump,

one of the sections of the handle being provided with perforations to regulate the force of the vacuum.

961,427. PRESSURE-REGULATING DEVICE FOR PNEUMATIC TIRES. Cornelius J. Brosnan, Springfield, Mass.

961,456. SPRAYING-MACHINE. James G. Mastin, Chicago, Ill.

961,638. STEAM AND AIR PIPE COUPLING FOR CARS. Richard Benjamin Painton, Williamsport, Pa.

961,658. WINDMILL. John A. Swanson, Canton, S. D.

961,710. MEANS FOR DRYING AIR. Louis Block, Mamaroneck, N. Y.

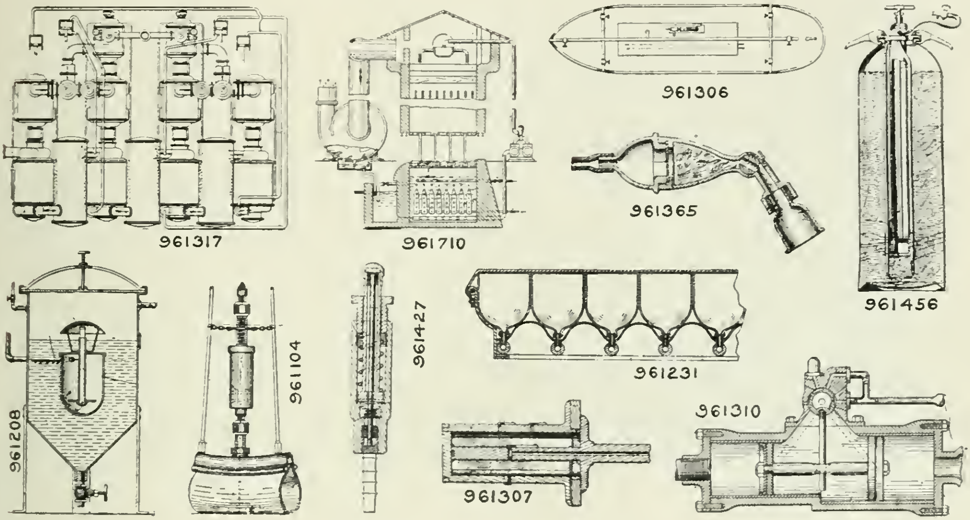
JUNE 21.

961,766. WIND-MOTOR. Thomas H. E. Folger, Corral, Idaho.

961,788. SINKING SHAFTS OR THE LIKE. Daniel E. Moran, Mendham, N. J.

1. In the sinking of shafts or the like, the method which consists in introducing air alongside the shaft to facilitate its descent.

961,932. PULSATOR FOR MILKING-MACHINES. David Brown, Spokane, Wash.



Pneumatic Patents, June 14.

961,960. MILKING-MACHINE. Milton A. Hicks, Weathersfield, Vt.

961,999. PNEUMATIC-TUBE SYSTEM. Birney C. Batcheller, Philadelphia, Pa.

962,019. DIVING-BELL APPARATUS FOR SUBMARINE WORK. John Garnar Flood, Westcliffe-on-Sea, and William George Fitzgerald, West Ealing, England.

962,045. CARRIER FOR PNEUMATIC-DESPATCH TUBES. Albert W. Pearsall, Lowell, Mass.

962,068. PNEUMATIC STACKER. James A. Walsh, Indianapolis, Ind.

962,072. PNEUMATIC-DESPATCH-TUBE APPARATUS. Louis G. Bartlett, Somerville, Mass.

962,203. GAS-COMPRESSOR. Ralph W. Emerson and Frank Bishop, South Bend, Ind.

962,217. AIR-GUN. George E. Heckman, Brice, Tex.

962,246. PNEUMATIC SPRING. Albert F. Rockwell, Bristol, Conn.

962,284. AIR-COOLING APPARATUS. Robert G. Wilson, Alaska, W. Va.

962,350. ROCK-DRILL. Herman J. Hibschle, Victor, Colo.

962,386. AIRSHIP. George D. S. Reece, St. Louis, Mo.

JUNE 28.

962,511. FLUID-PRESSURE IMPACT-ENGINE. John Kincaid, Vancouver, British Columbia, Canada.

962,517. AIR-BRAKE. James F. McElroy, Albany, N. Y.

962,534. COIN-CONTROLLED PNEUMATICALLY-OPERATED MUSICAL INSTRUMENT. Thornton I. Shannon and Fred M. Garnett, Columbus, Ohio.

962,546-7. AIR-BRAKE APPARATUS. Henry F. Bickel, New York, N. Y.

962,537. TEMPO-CONTROLLER FOR AUTOMATIC PIANOS. Albert H. Stuart, Boston, Mass.

2. In an automatic piano, a pneumatic motor, an exhaust pump and conduit communicating therewith, said conduit including a pneumatic and a port opening into the pneumatic, and a valve mounted on the movable wall of the pneumatic so as to move endwise in and out of said port, said valve having a controlling surface inclined to the line of travel and formed of graduated width narrower toward the ends and broader between the ends.

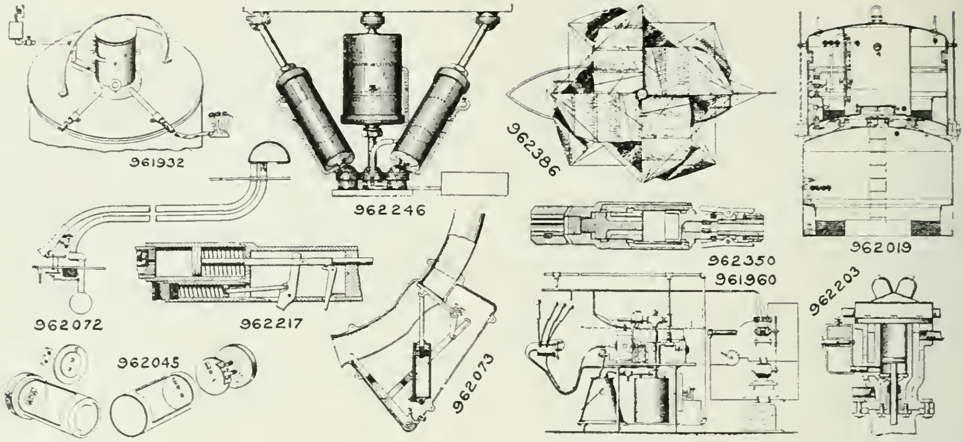
962,569. PNEUMATIC CLEANER. Frederick H. Hirth, Grand Rapids, Mich.

962,592. COMPRESSOR. Henry D. Shelton, Hughesville, Mo.

1. In an apparatus of the class described, two spaced air compressing pumps having reciprocating pistons in alinement and means for causing the simultaneous actuation of the pump pistons comprising a rotatable member having its axis of rotation parallel with the longitudinal axis of the pumps and its periphery extending beyond the longitudinal axis of the pumps, rollers engaging opposite sides of the said member adjacent to its periphery, and drums on each side of the rotatable member and of less diameter than said rotatable member, each of said drums being provided with an actuating flange or ledge engaging a respective pump piston rod.

962,612. MEANS FOR EXTRACTING GOLD FROM RIVER-BEDS. John H. Batten, Jamestown, Cal.

A device of the character described comprising a drum, means admitting compressed air to said drum, a man way disposed at right angles to



Pneumatic Patents, June 21.

said drum, a door opening from said man way to the atmosphere and a door opening from said man way into said drum.

962,688. AUTOMATIC BELL-RINGER. Christian Aalborg, Wilkinsburg, Pa.

962,696. STRAIGHT-AIR-BRAKE ATTACHMENT FOR AUTOMATIC SYSTEMS. Willard R. Chandler, Branchville, S. C.

962,713. ELECTROPNEUMATICALLY-OPERATED CONTROLLER. Joseph N. Mahoney, Wilkinsburg, Pa.

962,717. VALVE FOR HAMMER-DRILLS. Vincent J. O'Brien, Denver, Colo.

962,720. DEVICE FOR EQUALLY DIVIDING AND DISTRIBUTING A CURRENT OF AIR. Henry F. Rand, Tacoma, Wash.

962,755. ELECTROPNEUMATIC TRACK-CHANNELER. Arthur Henry Gibson, Easton, Pa.

962,796. CARRIER FOR PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles F. Stoddard, Boston, Mass.

962,797. PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles F. Stoddard, Boston, Mass.

962-853-4. PNEUMATIC-DESPATCH-TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

962,901. MASSAGE APPARATUS. Henry C. Karpenstein, New York, N. Y.

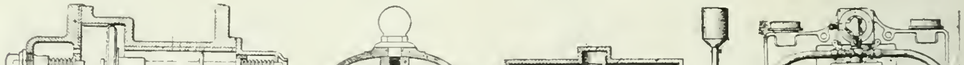
1. A massage apparatus comprisng a fluid-conduit, an air-conduit opening into said fluid-conduit, a valve in the air-conduit, and a massage implement connected with the air-conduit.

962,964. AIRSHIP. Theodore Kornbrodt, Chicago, Ill.

962,977. AIRSHIP. August Richard Rieger, Chicago, Ill.

962,980. AUTOMATIC AIR-BRAKE COUPLING. Forrest H. Roe, Batesville, Ohio.

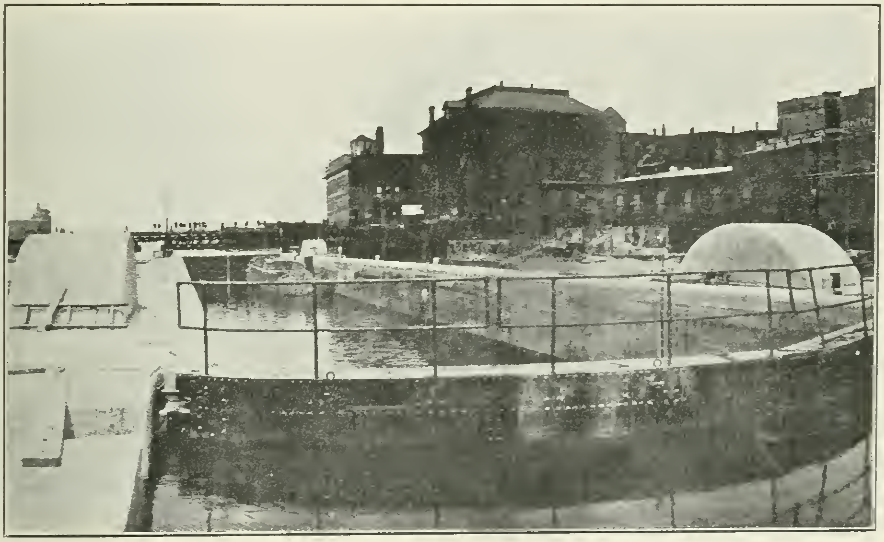
963,010. HYDROCARBON-BURNER. Ira L. Owens, Effingham, Kans.



Pneumatic Patents, June 28.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV SEPTEMBER, 1910 No. 9



SIPHON LOCK ON THE BARGE CANAL.

THE SIPHON LOCK ON THE NEW YORK STATE BARGE CANAL

In the city of Oswego, and standing at the head of the harbor which has been formed where the waters of central New York discharge into Lake Ontario, has been constructed a canal lock of interesting pattern, the only example of the siphon lock on the Barge canal, the first of the type to be built in this country and the largest in the world using the siphon principle. The following description of this interesting lock is taken from the July issue of the *Barge Canal Bulletin.*

In the locks of the type used elsewhere on the Barge canal the chambers are filled and emptied through culverts running inside the walls, having the necessary side openings, entrances and outlets, and placed so that the water will run through them by the action of gravity, or, in other words, so that it will always run down hill. Near the upper and lower ends of these culverts are placed large steel valves which move up and down in slots in the walls. Each of these valves rolls on four wheels attached to its framework, and is rectangular in shape and slightly larger than the culvert it closes. Near the top of the wall counterweights are provided, together with cables and machinery for pulling up and letting down the valves.

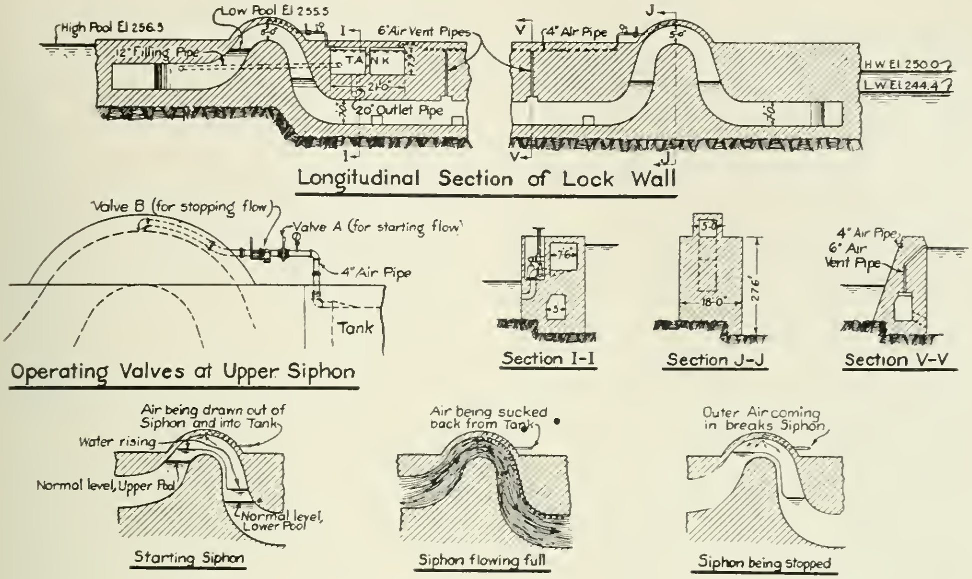
With a lock of the siphon type the general design of the culverts is similar to that of a lock of ordinary type, except that at the upper and lower ends the culverts are curved up so as to make necks, which rise a little way above the highest water level and which at the same time are shut off from all communication with the outer air, except through the operating pipes. These necks are shown on the accompanying drawing. While the lock chamber is filled and emptied by water operating under the action of gravity, the flow is modified by siphonic action. All the water flowing into or out of the chamber runs uphill and over the crests of the siphons, lifing itself over the top of the lock walls before it begins to run down into the lower levels of the culverts.

The first lock of this type was completed about 1896, on a canal in northern Germany, and was designed by Professor Hotopp, of Hanover. As its operation proved to be simple and successful, the remaining six locks on this canal were also made of the siphon type and others have been built here and there in Germany since that time. The chief advantages which they possess are those of simple and cheap operation and maintenance, as there is no complication with machinery or motors, and no large culvert valves to be operated under water, but all the movements are made by direct action of the head of water on the air pipes and are controlled by hand valves, all parts being easily acessible and simple in design. The head of water moreover, not only supplies the motive power, but automatically renews it during each operation. Deterioration of steel work under water by rusting is also eliminated, and in the case of the lock at Oswego it was found that the siphon type was the more economical as compared with the design which would have been used for a lock of ordinary type at the same site.

Looking at the drawing, it will be noticed that at the upper end of the wall there is a space marked "Tank." This is a space 7½ ft wide, 7¾ ft. high and 21 ft. long, with a center partition, built in the wall and communicating by means of pipes with the upper and lower levels and with each siphon in the same wall. One of these tanks is provided at the upper end of each lock wall and each one is entirely shut off from communicating with the outer air, except through the pipes and through a manhole with an airtight cover. One pipe, 12 in. in diameter, is used to fill the tank: another pipe, 20 in. in diameter, is used to empty it, and the remaining two pipes, each 4 in. in diameter, are connected with the siphons and used for the operation of the lock. The cubic contents of the tank are nearly half as much again as the contents of one of the siphons, measuring from low pool levels at the lock.

The operating power for filling or emptying the chamber is obtained as follows: The 12-in. pipe for filling the tank is first opened, the 20-in. emptying pipe, of course, being closed. The water from the upper pool then rushes into the tank, the air escaping through the valve marked *B*. This necessitates, of course, that the valve marked *A* should be open also. During this operation the neck of the siphon is temporarily in communication with the outer air, but as there is no drawing tendency of the air, the level of the water in the siphon does not change. The air escapes through the pipe with considerable force, and the tank is filled in about 4 minutes from the time of beginning to open the 12-inch valve. This valve, together with the controlling valves "A" and "B," is then closed, and it must be seen, of course, that the corresponding valve "A" at the lower end of the lock also is closed, thus cutting off communication between the tank and both its siphons. On opening the 20-inch outlet valve there is produced in the tank the effect of a body of suspended water tending to escape into the lower pool. As the tank is now shut off from all communication with the outer air, the water remains suspended by its weight and thus produces the vacuum necessary for operation. For the convenience of the operator a vacuum gage is placed at each siphon, so that he can tell how much operating power is available. During the filling of the tank the needle of the gage stands at zero, but as soon as the filling is completed and the opening of the 20-inch valve has begun, the needle begins to move slowly upwards, stopping finally at the difference in head between the upper and lower pools. This, as is usual with vacuum gages, is indicated in inches of mercury. The average head under which the lock will operate will be 8 or 9 ft., and would be indicated by a reading of about 7 to 8 in. on the dial.

With the tank filled and the outlet valve open, everything is ready to start the flow of water. This takes place as follows: Suppose it is desired to fill the lock. The valve *A* stands closed and the valve *B*, which communicates with the outer air, must also be closed. Valve A is then opened and the air in the siphon rushes into the vacuum in the tank displacing part of the water in the latter and permitting it to escape into the river through the 20-in



SKETCHES SHOWING ACTION OF SIPHON

outlet. Reference to the drawing will show the manner in which the water rises in the siphon. After it has reached the crest it begins to flow over into the culvert below. The tank continues to draw out the air, and as soon as the water in the siphon has risen to about one-third of the height between the crest and the crown, equal in this instance to a little less than 2 ft., part of the air begins to be carried out through the culvert, and the siphon thereafter fills itself automatically. All the foregoing action takes place rapidly, and under an 8-ft. head the siphon begins to prime itself in from 30 to 40 seconds. At this time the needle of the gauge, which recedes several inches as soon as valve *A* is opened, begins to climb again, and the siphon at the same moment reverses the action of the tank, so that instead of the air being drawn into the tank, the siphon begins to draw it back from the tank and to carry it out into the culvert. A certain amount of water from the river flows up into the tank at the same time through the 20-in. outlet pipe and supplies the place of the air, so that in a few minutes after valve A has been opened the original vacuum is restored in the tank. The movement still continues, however, and only stops when the tank and the pipes have all been drawn full of water, at which time the needle usually registers 3 or 4 in. more of vacuum than at the time of starting. Some experiments were made with a float gauge in the tank to ascertain the rise and fall of the water, and it appeared that when the reversing action began, the operating head of water in the tank was nearly 2 ft. in excess of the head in the siphon. It would have been expected, therefore, that the tank would have continued to draw air out of the siphon until this head was neutralized, but in point of fact the draft of the siphon was so strong that it not only overcame this differ-

LOWER SIPHON AND VALVES.

ence but drew water into the tank, thus filling it again completely.

The air which is carried out by the water escapes partly in small bubbles through the culvert ports, but chiefly through tne air vents in the walls, shown on the drawing. At first there is a discharge of mingled air and water, which is thrown a few feet from the lock wall, but as the flow through the siphon increases, the jets also increase until they occasionally blow a cloud of spray 50 or 60 ft. If this discharge should at some time cause inconvenience to boats, it will probably be remedied by cutting recesses in the walls and bolting baffle plates in front of the pipes. Practically all the discharge of air takes place through the upstream vents and the culvert ports and only a small portion reaches the lower vents.

With both siphons in use the lock chamber can be filled in 4½ to 5 minutes, and as the water reaches the final level there is noticed the "surge" usual with lock chambers of this size. This means that the columns of flowing water continue to run a few seconds after the level in the chamber has reached that outside so that the chamber level still continues to rise slightly and in so doing starts open the lock gates. With lock gates operated by hand this feature is often of much assistance to the lock-tenders in commencing to open the gates.

When the chamber is filled and prior to starting the lower siphon, valve *A* must be closed and valve *B*, which admits the air to the upper siphon, must be opened, thus allowing the water in the neck to fall below the level of the crest. Unless this is done, any difference of level in the lock chamber caused by commencing to empty it would start the water in the neck of the siphon running again, and it would be impossible to empty the chamber without thus stopping the flow.

In order to empty the lock the same process is used as for filling it. In case the valve *B* at the lower siphon was not left open during the filling of the chamber, so that the air in the siphon could find an escape as the water rose, it must be opened for a few seconds and then be closed again before starting to empty the chamber, as otherwise there would be an excess of air inside, which would go far to neutralize the vacuum in the tank. The lower siphons are less rapid than the upper ones in starting, as the air has to travel to the tank through some 250 feet of pipe in each wall and around several bends. Moreover, the air which the water begins to carry out after the siphon has started to prime itself does not appear to escape as readily as at the upper end, as it has a less direct route to travel before it can get free. Tests showed that the operation takes from three-quarters to a minute longer, the first discharge of air appearing at the culvert outlet in from 1½ to 1¾ minutes. The vacuum gage, however, indicates that the flow of air from the siphon to the tank reverses in about 45 seconds. As the outflow increases, the amount of air carried in the water continues to increase, and the discharge for a minute or two is a compound of air-bubbles and water changing gradually until all the air has been discharged. The vacuum gage in a manner similar to that described for the upper siphon, commences to register a steadily increasing pull until, when the discharge is in full play, it sometimes reaches as high as 13 or 14 inches, or nearly double that at the commencement of the operation. After the flow has stopped, the needle gradually settles back to the original figure indicated. The emptying of the lock, using both siphons, takes 5½ to 6 minutes.

It will be seen from the foregoing description that once the tanks have been made ready for work the operating power is self-renewing, so that, were there no leakage of air into the tanks, lockages could be conducted at any time and by merely manipulating the 4-inch air valves. While tests for leakage have not yet been concluded, the experience obtained thus far seems to indicate that the tank will retain a sufficient vacuum for 2 or 3 hours after the last lockage. However, in order to avoid having to refill the tank when traffic is very infrequent, the plan has been adopted of closing the 20-inch outlet valve, thus holding the water in the tank. On opening the valve again the apparatus is at once ready for use.

The highest kite flight on record was made at the Mount Weather Observatory of the United States Weather Bureau May 5th, 1910, when altitude of 7,262 meters (23,826 feet) above sea level was attained. The highest previous flight was made at the same observatory October 3rd, 1907, when an altitude of 7,044 meters was reached. The altitude of the observatory is 526 meters (1,722 feet).

THE ENERGY OF COMPRESSED AIR

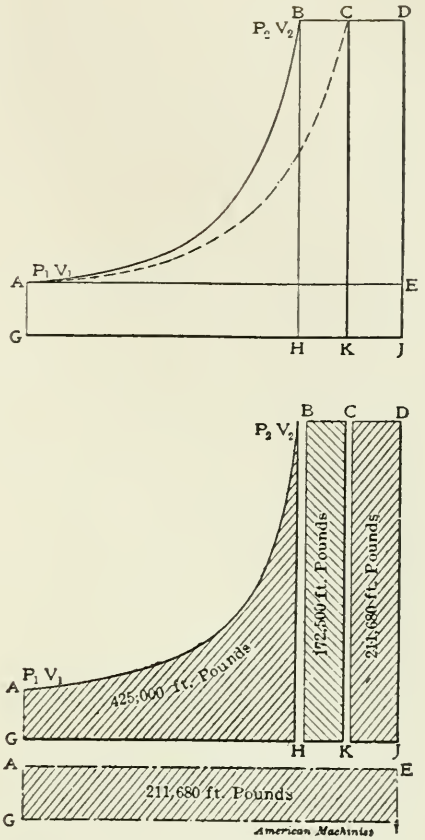
By Snowden B. Redfield.

Up to the present time, for many classes of work, no other medium of power transmission has successfully taken the place of compressed air. Its ultimate economy in dollars and cents is well recognized, but there still are many phases of its nature not universally understood which have led to the promotion of schemes for power development and transmission, with which, if the backers and those brought into the transaction were more conversant, they would have nothing to do, and so would be spared financial loss.

The most universal piece of practical knowledge on the subject of compressed air is the fact that it requires power to compress it, and that when once compressed it has the capacity of doing work in various machines designed for that purpose. It is also known, though not so widely, that the transformation of power into compressed air, and from compressed air back to power again, involves considerable loss. Another well known fact is that air while being compressed becomes greatly heated, and that while expanding in the working machine it grows intensely cold, as is often evidenced by the freezing of exhaust ports of pneumatic machines, much to the discomfort and annoyance of the operators.

What is probably not often realized by the practical man is the fact that the greatest losses in power economy of compressed air are due directly to these evidences of heat and cold. However, what would probably prove the crowning surprise to this practical man would be the statement that, of all the energy in the coal burned to drive the compressor, not one foot-pound of this energy reaches his air-operated machine through the compressed air, but that what really drives this machine is the expansion of the atmosphere itself and that the energy required to expand this atmosphere comes from the heat in the atmosphere.

The truth of the matter is that all the work done upon the air in compressing it is transformed into heat, and this heat is usually entirely dissipated into the water jackets and intercooler of the compressor and aftercooler if one is used, or in radiation from the pipe line, before reaching the driven machine. The compressed air reaching its destination at atmospheric temperature, no matter what its pressure, contains not one foot-pound more energy than it contained before compression.



Components of an Air-compressor Indicator Diagram

These are very radical statements and those who are interested will insist upon convincing proof before accepting them as truths. The proof of these statements must necessarily involve theory and mathematics, but in order to overcome the well known popular aversion to formulas, the arithmetical results of each step will simply be stated.

CONDITION OF THE PROBLEM.

The diagrams shown will be recognized as an adiabatic single-stage indicator diagram of an air compressor, the lower one being separated into its component parts. The area *A B D E* represents the net work done in the compressing cylinder. The line *A E* represents the absolute pressure of the atmosphere or 14.7 pounds per square inch, and the line *B D* represents the discharge pressure, which, to illustrate a practical case, is made 114.7 pounds per square inch absolute, or 100 pounds gage. To avoid decimals, the volume represented by the length $A E$ may be taken to represent a cylinder volume of 100 cubic feet, and it will be assumed that the piston makes one stroke per minute, thus compressing 100 cubic feet of free air from atmosphere to 100 pounds gage pressure in one minute.

WORK DONE IN COMPRESSING THE AIR.

The principles of thermodynamics, as illustrated by the familiar indicator diagram, teach us that the work done in compressing a gas from one pressure and volume to another, by any law that may be represented by a line, as for instance the adiabatic curve $A B$, is equal to the entire area under that line, down to the absolute zero line, this area, of course, being figured to the proper scale.

Bearing this in mind, we have that in moving the piston to compress the air in the cylinder under consideration, from pressure and volume $P_1 V_1$ to pressure and volume $P_2 V_2$, the work done on the air by the piston is represented by the entire area under the curve $A B$, *or* the diagram $A B H G$, taken to the proper scale.

In doing this work, the piston is supposed to have traveled from position $A G$ to position $B H$ and, of course, no back stroke in the other direction is supposed to have yet been taken. The total area of this part of the diagram figured, or measured, and taken to the proper scale, will be found to be 425,000 foot-pounds. This is the work done in compressing the air from volume $G J$, or 100 cubic feet, to volume $H J$ and raising its pressure from atmosphere to 100 pounds gage. Starting with 100 cubic feet and atmospheric pressure, and compressing to 100 pounds by adiabatic compression, the volume of the air $H J$ or V_2 will be 23.26 cubic feet.

EXPELLING THE AIR FROM THE CYLINDER.

Let the curve $A C$ represent that of isothermal compression. The law of this compression is that the temperature remains constant throughout its entire range, and that the product of the absolute pressure and volume at any point is equal to their product at any other point. Under these circumstances, the volume of the air represented by the length $C D$ will be 12.816 cubic feet. In advancing the piston to position $C K$ from position $B H$, pushing the air out of the cylinder through the discharge valves at 100 pounds pressure, the work done by the piston is area $B C K H$ and is the volume $H K$, multiplied by the pressure per square foot, or $(23.26—12.816)\times 114.7\times 144=172{,}500$ foot-pounds. Then the entire work done by the piston from the beginning of the stroke to position $C K$ is $425{,}000+172{,}500=597{,}500$ foot-pounds.

WORK DONE BY THE ATMOSPHERE.

The work required to push the rest of the air out of the cylinder into the receiver at 100 pounds gage pressure will be area $C D J K$ and is, by a similar calculation, 211,680 foot-pounds, bringing the total work done by the piston up to 809,180 foot-pounds to compress 100 cubic feet of free air from atmosphere to 100 pounds pressure and force it out of the cylinder and into the receiver. Now all of this work did not come from the motive power driving the compressor, for while the piston has been moving forward, compressing the air, the atmosphere has been exerting a pressure on the back of the piston, of 14.7 pounds per square inch absolute, and helping the piston. The work done by the atmosphere and represented by area $A E J G$ is then the product of the atmospheric pressure and the volume swept through, or 211,n80 foot-pounds; which it will be noted, is the same as the work done in area $C D J K$. This leaves the net work done by the motive power of the compressor, 809,180, less 211,680 or 597,500 foot-pounds and this amount of work has actually come out of the coal pile.

THE PART PLAYED BY HEAT.

Now that this amount of work is proved to have been done by the compressor let us see what has become of it. At the point B, the air is very hot, due to the compression. Its temperature may be calculated by the adiabatic formula and assuming 60 degrees Fahrenheit initial temperature, we will find 484 degree Fahrenheit at point B. After the air has passed out of the cylinder and again cooled down to atmospheric temperature, in the pipe line, its volume will have shrunk to the length $C D$, which has already been shown to be 12.816 cubic feet. In thus cooling and shrinking, the air has given out an amount of heat equal to the weight of the air multiplied by its specific heat, and by the difference in temperature. The weight of the 100 cubic feet of free air originally in the cylinder at 60 degrees Fahrenheit is 7.63 pounds and this weight will not have changed, no matter what the pressure and volume, so the heat lost from the air during the process of cooling, after compression, and before reaching the driven machine is $7.63 \times 0.2375\ (484 - 60) = 768$ British thermal units.

In this expression, the figure 0.2375 is the specific heat of air at constant pressure.

A British thermal unit is equivalent to 778 foot-pounds of work, so the amount of work lost by the radiation of the heat of the air is 768×778 or 597,500 foot-pounds.

A glance back will recall that the amount of work actually coming from the coal pile to drive the compressor in compressing and expelling 100 cubic feet of free air, at 100 pounds pressure was actually 597,500 foot-pounds. What could be more convincing than this, that all the work done by the compressing engine has been dissipated in radiation of heat from the compressed air, on the way to the air-driven machine? One thing will perhaps be more convincing. It is this: In compressing 100 cubic feet of free air to 100 pounds pressure in one minute, by single-stage adiabatic compression, the indicated horsepower in the compressing cylinder will be, by the well known formula:

$\text{I.h.p.} = 1.511\ P_1\ (R \quad - 1)$ where P_1 is the absolute initial pressure in pounds per square inch and R is the ratio of compression. This gives 18.106 indicated horsepower per 100 cubic feet per minute. Expressed in foot-pounds, thus:

$$18.106 \times 33{,}000 = 597{,}500 \text{ or } \frac{597{,}500}{778}$$

$= 768$ British thermal units. Thus all signs point to the fact that the work done by the coal pile has disappeared into heat.

It should be further noted that the initial temperature of the air entering the compressor cylinder will not affect the power. A higher initial temperature will result in a higher final temperature, but being warmer, there is a less weight of air admitted to the cylinder per stroke and *vice versa.*

THE REAL SOURCE OF THE POWER

So far so good, but if all the work has been lost in heat, what drives the pneumatic hammers, drills and so forth? Looking back again at the indicator diagram and remembering that the air after being compressed and cooled, has a volume represented by the length *C D* or, as has been shown, 12.816 cubic feet, it will be realized that this is the volume of air entering the pneumatic machine driven, and this is the piston displacement of this machine per minute or during the time that the compressor was compressing and discharging the 100 cubic feet of atmospheric air just considered. As this air is admitted to the driven cylinder at 100 pounds pressure, or 114.7 pounds absolute, the work done on the face of its piston during this time will be the product of the displacement and the pressure acting, or $12.816 \times 114.7 \times 144$ or 211,680 foot-pounds, which is exactly the same as the area *C D J K*, which is also the same as area *A E J G*, which latter, it has been shown, was the work done on the back of the piston of the compressor by the atmosphere.

This now proves that all the work done in the air-driven tool has come from the expansion of the atmosphere, acting on the compressor piston, which is the assertion, the truth of which we have been endeavoring to establish.

EFFICIENCIES.

Beyond this is the fact that the whole of this work does not actually reach the tool, and this aside from mechanical friction, which has not been considered at all in this discussion. The further loss of work is due to the fact that on the other side of the driven piston the atmosphere is exerting a pressure of 14.7 pounds absolute, tending to retard it. This work of retardation again amounts to the product of the displacement and the atmospheric pressure, or 27,129 foot-pounds, and this deducted from the work done by the entering air, leaves a net amount of work which, neglecting mechanical friction, actually reaches the tool, of 184,551 foot-pounds.

This is the amount of useful energy obtained from an expenditure of 597,500 foot-pounds of work given up by the compressing engine, or an efficiency of

$$\frac{184{,}551}{597{,}500} \times 100 = 30.9 \text{ per cent.}$$

This is the theoretical "thermal efficiency" of an air compressor and a pneumatic tool, rock drill, or similar device using air nonexpansively at 100 pounds pressure, compressed in a single stage, and does not include pressure drop, leakage or friction losses. These mechanical losses would reduce the practical efficiency to about half of the theoretical value, making the actual efficiency probably about 15 per cent.

If the compression had been compound, to 100 pounds pressure, the theoretical thermal efficiency of the compressor and tool would be 36.4 per cent. and the actual efficiency probably about 18 per cent. This thermal efficiency depends upon the air pressure used, and decreases as the pressure increases. Also the lower the pressure, the higher the efficiency, but in order to do a given amount of work with a low pressure, it would be necessary to increase the size of the driven cylinder, and it has been found that the most commercial sizes, combined with power economy, leakage, etc., demand a pressure between 80 and 100 pounds.

Objection may be made that this discussion is based upon the adiabatic compression curve and so is not practical. The fact is that while the actual compression curve is slightly below the adiabatic, this means that some of the work of the air compressor goes directly into the water jackets as heat, instead of being lost in radiation from the pipe line later. The argument would be the same under these practical conditions, with the actual temperatures and pressures, for the practical compression curve can be mathematically expressed just as well as the adiabatic, but the explanation and argument would be much more complicated and would lead to the same result.

If compressed air is so wasteful of power, why is it becoming more and more widely used? The answer to this question is that the vast saving in labor cost as opposed to other methods of working, so far overbalances the comparatively low power economy that the latter feature is secondary, and also many things can be done with compressed air that can be done with nothing else.

The power economy of compressed air may be increased by various means: Compounding, expansion and reheating, all of which subjects have been discussed in previous articles. —*American Machinist.*

Vanadium cast iron was specified for the cylinders of 183 new locomotives recently built for the N. Y. C. and H. R. R. A pair of cylinders of this material in service two years, on an engine which ran 200,000 miles, showed only microscopical wear.

LARGE FUEL OIL VAPORIZER

The sketch herewith represents in detail a high-pressure oil vaporizer or burner that has given good results in one of the largest forge shops in the middle West. It was designed by the superintendent and brought to its present efficiency after several month's of experimenting. Several different types of high and low-pressure burners were secured from prominent houses and fitted to the furnaces under the eye of the demonstrators that came to superintend the installations. We had all the facilities necessary to try each burner under conditions prescribed for it, namely, fan blast, 6 ounces; compressed air, 100 pounds; oil pressure, 40 pounds; and the use of reducing valves, pressure gages, a standard oil meter and the old reliable stand pipe or tank that could be filled with oil and the amount of oil used by each burner could be determined to an ounce.

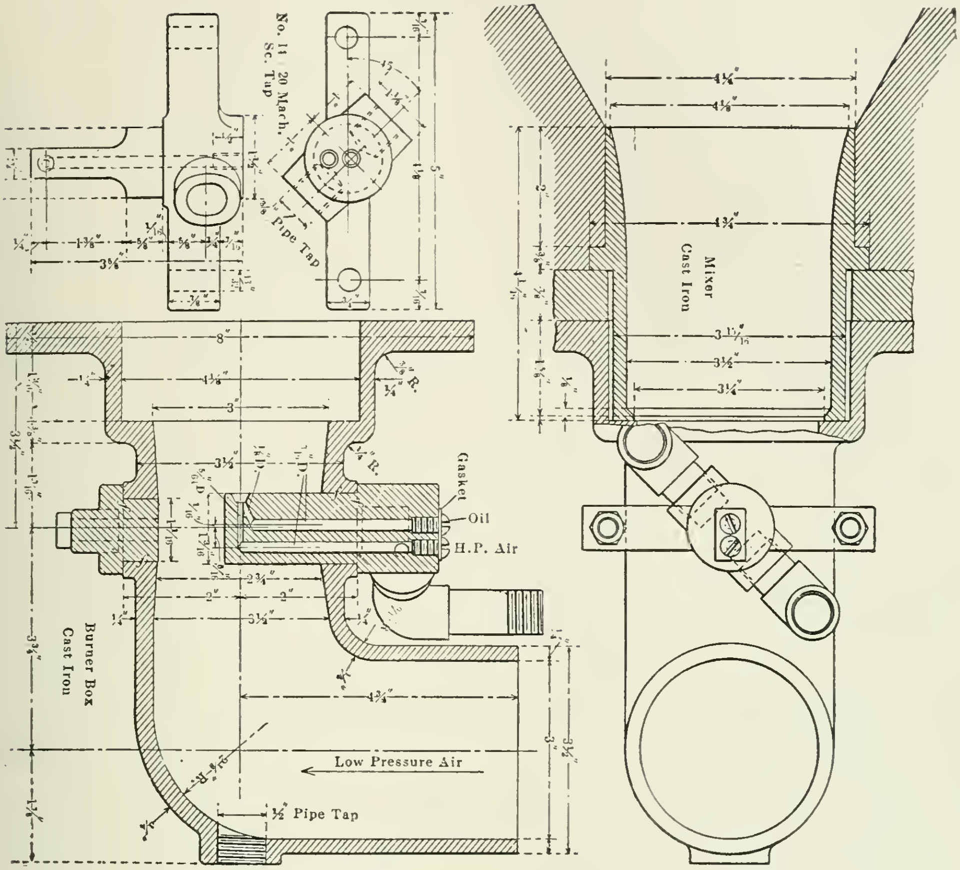
The burner had to heat a furnace 3½x5 feet and 14 inches high. No rules were laid down as to how the furnace should be built, and it could be fired from the front, back or side.

The cost of building the furnace; amount of oil consumed per hour; time required to bring furnace up to the required heat after lighting; control of the fire; and the time steel could be exposed to the flames with the mimimum amount of scale, were the points that would decide for or against the burner.

With the low-pressure burners we found that the time required to light the furnace and raise it to the proper heat was one hour and fifteen minutes; the amount of oil consumed was nine gallons per hour. The oil not being properly broken up or vaporized, made it difficult to light and the furnace smoked so badly while heating up that we discarded this kind of burner early in the game. We then turned our attention to the high-pressure burners, which had their good points and burned about the same amount of oil.

They all required so much fan blast and compressed air that the amount of scale that formed on the steel gave us no end of trouble.

We then found that by reducing the compressed air to seven pounds and the oil to thirty, with just enough fan blast to keep a circulation in the furnaces, we could get ideal results with the vaporizer shown. Some of the others failed to work successfully on this amount of air and others that did, were dis-



LARGE OIL VAPARIZER.

carded because the valve was difficult to clean when it stopped up.

With the burners shown, it is not necessary to strain the oil and the heavy grades will work satisfactorily. The mixer casting is cemented to the furnace. As the burner box bolts against the same, a tight joint can be made with a small amount of asbestos cement and prevent the oil from running down outside.

The blast gate is fitted to the top of the burner box to control the blast and the oil and compressed-air pipes are fitted with needle valves. The mixer nozzle channels can be cleaned without disconnecting the piping by removing small screws on the top and inserting a wire, a feature that is very desirable. The hole in the back of the burner box enables the operator to see the effect of the blast on the fire and see the end of the mixer nozzle while cleaning the same. We have had good success with this burner for the last two years and have placed it in the hands of others to try. All speak in the highest terms of its efficiency.—*Forgeman, Cleveland, in American Machinist.*

USE AND CARE OF PNEUMATIC TOOLS

[The following comprises the essential portions of an address by Mr. J. H. Simons, of the Chicago office of the Ingersoll-Rand Company, before the Railway Tool Foremen's Association.]

It is doubtful if any piece of machinery pays a greater profit on its investment or cost than a pneumatic hammer or a pneumatic drill kept in good working condition, yet it is equally doubtful if there is any piece of high-speed machinery so much abused by neglect to properly clean, oil and renew worn parts, which condition retards the full admission of air to all the parts, interfering with the free movement, and rapidly cuts down the efficiency and capacity of the tools. Pneumatic tools, like all other high class machinery, must receive proper care and lubrication to give the best results. One of the most important factors connected with their proper care is to keep them clean and well lubricated. All pneumatic tool companies should proportion and construct their pneumatic tools in such a way that none of the parts will break from actual service unless some part is defective and escapes the different inspectors' notice at the factory, which is liable to happen once in a great while in the most up-to-date and best regulated plant in the world, but if a wood boring drill, or a metal drill, is improperly applied; that is, used on other work than for which it was designed and built, or overloaded by forcing it beyond its rated capacity, something may happen. For instance, if a drill is constructed to drill 1¼ in. holes and is used for drilling 2 in. or 2½ in. holes, then that something may happen.

It is reasonable, to expect, and it is a fact, that in pneumatic tools, as in all other high-speed machines, the rapidly moving parts will wear in time—the pistons, ball races, balls, throttle valves, etc., in pneumatic drills, and the throttle levers, bushings, valves, pistons and cylinders on pneumatic hammers, and when the wear is sufficient to prevent the full and free admission of air, or the escape of air by leakage past a worn part, it reduces the efficiency of the tools, and the part, or parts, should be removed. If this is done the machines will maintain their efficiency indefinitely.

The greatest abuse, therefore, to which pneumatic tools can be subjected is the failure to properly clean and lubricate them. An almost universal feeling seems to predominate on the part of operators that a pneumatic tool should run and develop its full power so long as all the parts are held together, without any regard to cleaning, oiling or tightening up. The cleaning and oiling of pneumatic tools should not be delayed until they stop working on account of dirt, rust or gummed oil. They should be thoroughly cleaned with kerosene or benzine once every twenty-four hours, as the air taken into the compressor generally contains some grit or dust. It is almost impossible to prevent this foreign matter entering the working parts of the tool, thus causing the parts to become clogged and rendering the tool inoperative. A good plan in such cases is to thoroughly clean by pouring benzine or kerosene freely into the throttle handle. This dislodges all foreign matter and cuts the thick oil, which can be removed by blowing the air under pressure through the tool, then lubricate in like manner with a good quality of light body oil. Sewing machine oil or a winter strained lard oil is very good. Heavy oils should never be used on pneumatic hammers or piston drills, as they cause the tool to work very sluggishly, with consequent loss of power. However, heavier oils should be used on the rotary type of drills.

When pneumatic tools are not in use it is a very good plan to keep them immersed in kerosene. They should be suspended so that the dirt and foreign matter will settle to the bottom of the vessel and then be thoroughly blown out and well lubricated before being put into operation, as kerosene leaves them dry. It will well repay any user of pneumatic tools to keep the inside of pneumatic tools as clean and well-oiled as a sportsman would his gun. We advocate, especially where the air is usually laden with foreign matter, the use of strainers on the tool and filters in the pipe line, arranged so that they can be readily taken apart and cleaned. A good form of pipe line filter is two cast flanged pieces properly tapped and threaded to fit the pipe line, bolted together, with a piece of gauze or fine mesh wire screen between. This can be made in any railroad shop. There are also sundry makes of automatic oilers for pneumatic tools, which are placed in the hose line a short distance from the tool, and which can be refilled at any time without disconnecting the tool from the hose line. They are made in sizes to supply oil for from six to eight hours without refilling.

Another abuse, especially with regard to pneumatic riveting hammers, is a rapidly increasing tendency on the part of operators, particularly where the hammers are used in construction of steel cars and in structural steel shops, more especially where "hunky" labor is employed, to use pistons shorter than those adopted by the makers as standard. This is the most flagrant abuse to which a riveting hammer can be subjected, and I cannot too strongly condemn this practice. The riveting hammers are designed with parts properly proportioned to meet the requirements of the various classes of work to which these tools are adapted. Workmen have discovered that a shorter piston than the one furnished with the hammer increases the number of blows per minute and for a time facilitates their work. They usually make these pistons by grinding down a broken standard piston, thus removing the hardening in a large degree, and leaving the striking part softer than it should be. These short pistons have a tendency to crumble, and the broken parts cut the inner casing of the cylinder, and if it is not damaged beyond repair from this cause it is only a question of a short time when the cylinder will crack or the handle will be broken. When cracked cylinders, broken handles and broken rivet sets are experienced the hammer should be carefully examined to ascertain whether or not the workman has substituted a short piston and this can only be done when the hammer is in service, as it has been found that the workmen carry the short pistons with them and make the exchange after taking the hammer out of the tool room, replacing the proper piston when returning the hammer at the close of the day. In some of the large manufacturing plants hammers have been discovered working with a short stub of a piston not more than two inches in length, ground conical on the striking end, and the managers of these plants have issued instructions making it an offense punishable by discharge where such conditions are found. One of our largest industrial organizations, operating some eight or ten plants, inaugurated about a year ago a system for keeping a thorough inspection and record of pneumatic tools from the day of purchase until they had become obsolete or worn out. A record is kept of every item of repair made to a tool and a report is filed showing why the repairs are made necessary, that is, whether from abuse, lack of care, bad hose, natural wear and tear, or accident. The mechanical engineer in charge recently informed me that in looking over the report for the first six months he was greatly surprised to find that about 30 per cent. of the causes of repairs could be directly attributed to neglect in cleaning and oiling and about 15 per cent. to the use of inferior hose.

IMPORTANCE OF AIR PRESSURE.

Another important factor to be considered in the getting of the very best results out of pneumatic tools is the air pressure. We have found after a very careful and paintaking investigation that, so far as the air pressure is concerned, one should have between 90 and 100 pounds of air to get the best results. The Canadian Government will not accept steam tight rivets driven with pneumatic hammers unless these hammers are operated by 110 pounds air pressure. All pneumatic tools can be operated on less pressure, but you will find, as I say, that 90 to 100 pounds of pressure will give the best results.

In conclusion allow me to offer a few suggestions applying to all makes of pneumatic tools, which, if followed, will insure you more and better work from your equipment and will obviate delays and annoyances and minimize the expense of maintenance.

First, see that the tools are well cleaned and boiled before putting them in operation.

See that the pipe lines are thoroughly blown out before connecting the tool.

Use the best quality of air hose. It is cheaper and more satisfactory in the long run.

See that your pipe lines are provided with filters or that strainers are used with the tools, preferably both.

With drills, adjust the ball-bearings, where they are provided, so as to take up the lost motion, and be sure that they are firmly held by the lock nuts to prevent working loose or tightening up and binding when in use.

With your pneumatic hammers be sure that the handle is always on tight, as the tools may be seriously injured by allowing this to work loose. This controls the joint between the handle in valve box and is of great importance.

See that the operators hold their riveting and chipping hammers firmly against the work. If the die or chisel is allowed to play in and out of the hammer while in operation it will seriously damage the tool. Every blow should be delivered on the die or chisel and not on the forward end of the bridge of the cylinder in chipping hammers. With riveting hammers, which have no bridge in the cylinder, it often means the loss of the die and piston by being shot out of the tool. Besides, in structural work it makes it dangerous to pedestrians in streets and thoroughfares below. There is no way of protecting against injuries of this nature except by care on the part of the operator.

See that the chisel and rivet sets fit properly in the nozzles and are of proper length, otherwise there is an opportunity for loss of power and injury to the tool.

IMPROVED OXY-ACETYLENE APPARATUS

The accompanying cuts show the essential features of an improved form of welding or metal cutting apparatus put out by J. M. Jackson & Company, Limited, of London, Manchester and Glasgow.

The casing of the generator is constructed of steel plate, welded at the joints by the process it is designed to work. It is fed with coarse-grained carbide, which while being cheaper, produces a greater volume of gas from a given weight than the fine-grained quality. A special feature is the ample size of the water tank, which effectually seals the apparatus and prevents the possibility of any escape of gas, while, as the whole of the gas has to pass up through this volume of water, it leaves the generator remarkably pure; although a scrubber is provided, this is more in the nature of a safeguard, as in practice it is not really necessary. The dimensions of the generator entirely eliminate heating troubles.

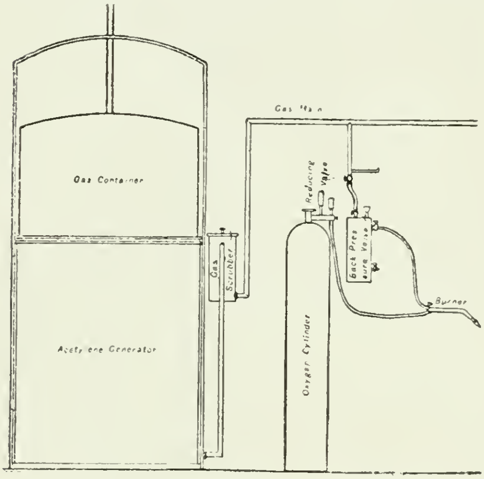


FIG. 1.

An important feature of this type of apparatus, which differentiates it from other makes should be noted. In this system the acetylene gas is generated in the water itself, and in consequence all the gas is got out of the carbide and the gas generated is purer and cooler; while, having to pass up through a large volume of water, the gas is entirely freed from sulphuretted and phosphoretted hydrogen.

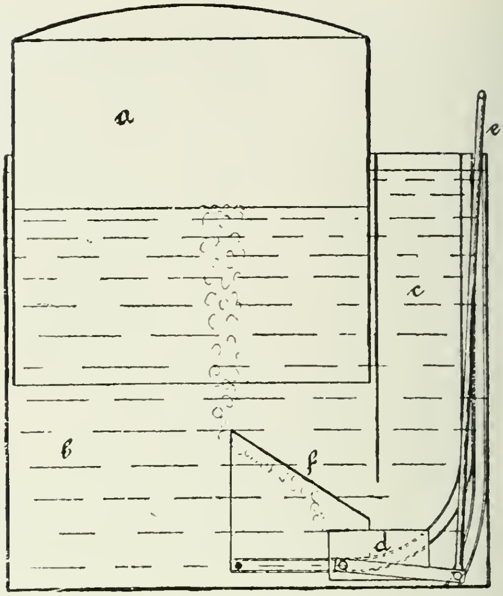


FIG. 2.

Fig. 2 shows the generator in section. The carbide is placed in a box having a perforated bottom which is placed the reverse way in a second box and again reversed into a third box *d*, which is attached by means of a swivel joint to the lower end of the feeding lever *e*. The box is then lowered by means of this lever, through guides fitted at the sides of the water-filled shaft *c*. These guides are given a curve at the bottom which, acting on the swivel joint, causes the box containing the charge to be delivered under the hood *f*. It will be readily seen that, owing to the construction of the box, the water cannot come into contact with the carbide until the box is in position, so that there is no escape up the shaft. From the gasometer the gas passes through the scrubber and thence to the valves. A hydraulic back pressure valve, which prevents backfiring, is fitted close to the operator and the equipment includes a reducing and controlling valve for attachment to the oxy-

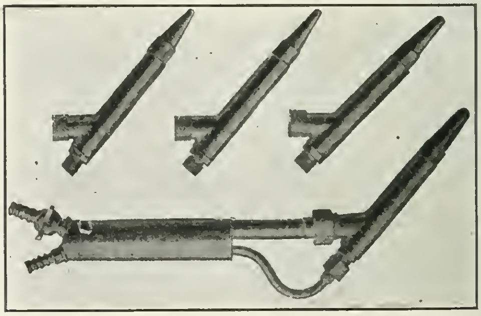


FIG. 3.

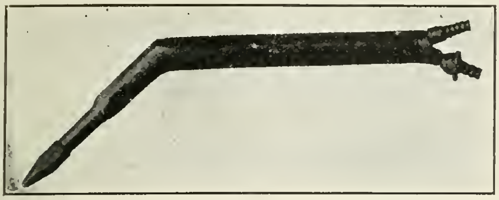


FIG. 4.

gen cylinder. The burners, which have been designed to economise gas and also insure perfect combustion, are made in two types. Where the work to be performed varies over a wide range of sizes, the burner consists of a mixing chamber with interchangeable burners, adapted to meet the particular requirement, see Fig. 3; where however, the work to be done is practically standard, the burner as in Fig. 4 is supplied.

EXTINGUISHING AN OIL WELL FIRE

On June 18 the Producers' Oil Co. drilled in its No. 6 well in the Hart's Ferry district of the Caddo field, in Louisiana. Several wells in the neighborhood had proved such vigorous gushers as to be hard to manage. Every precaution was taken to control this one by a 16-inch valve supposed to stand 800 pounds pressure.

The well began flowing at a greater rate than any well ever before drilled in the Caddo field, and has been variously estimated at from 8000 to 25,000 barrels a day. The effort was at once made to close it in pending the erection of suitable tankage, but a leaking nipple developed, so that, with the best they could do, some 3000 barrels of oil a day sprayed from the leading valves.

A "housing" was ordered from Shreveport with the hope of enclosing the valve, nipple and all, within a pair of castings which, when drawn together with bolts, would exactly fit around the entire valve and close the leak. On Sunday afternoon, June 19, while the castings were on the way to the field, a severe thunderstorm came up and caused great fear that the well might be ignited by lightning, an especially serious matter, as the well men working under this continuous shower of 3000 barrels of oil spray were constantly drenched with oil, which by the way, is about 43 degrees B. gravity, which means an oil with some 20 per cent. of gasoline and very inflammable. The general manager of the Producers' Company, Mr. James Sharp, who was personally in charge of the work ordered all the "greasy men" to run at once to the bank of Jeems Bayou, 100 feet away, and to plunge in if the storm came uncomfortably close. This was less than 10 minutes before the lightning struck and ignited the well, at 5 o'clock Sunday evening.

The situation now became a fight to extinguish this fire. The blaze of light oil was sprayed to an unusual height by the great volume of natural gas, and, with the gusty wind blowing the column of flame near to the ground in various directions, the danger to life and property was great.

The most practical scheme for extingushing the fire seemed to be to drown the flame by steam. This involved shipping 25 steam boilers from Shreveport by rail to Mooring's port. There they were unloaded and hauled about 300 yards to the bank of Ferry Lake. There is no wharf at the lake, and it was a tedious matter to reload the boilers onto barges, and it was no easy matter to tow these barges by way of the shallow lake and Jeems Bayou through the labyrinth of cypress trees and stumps to the nearest point to the well. There began the tedious work of getting the boilers up a muddy, slippery slope, and then of installing them. They were brought just as near to the fire as to avoid the licking flame should the wind drive it that way. Next a gang of expert pipefitters connected each boiler with a supply of natural gas from nearby wells. This alone would have taken a week in ordinary times, or say two months by day labor methods. Meanwhile another gang connected these boilers with steam pipes which were run still closer to the enemy to deliver the steam on the flame at short range. Word was sent to Shreveport that the flame would be extinguished at 6 o'clock Tuesday afternoon. As a matter of fact, it was put out one hour earlier. All the various features of assembling these boilers and getting up steam had been accomplished in just 48 hours of continuous work.—*Manufacturer's Record.*

GREAT GAS FIRE EXTINGUISHED BY STEAM

One of the greatest and at the same time the most spectacular of gas well fires in the history of the petroleum industry in California was recently conquered through the use of steam. The Standard Oil Company when boring for oil in the Midway field near the town of Taft opened up an immense reservoir of gas, the flow being under such terrific pressure that it wrecked the derrick. The combustible immediately took fire from the boiler, consuming the wreckage and driving the workmen in all directions from the scene. The enormous pressure, said by some to exceed 1000 pounds to the square inch, caused the gas to leave the well with such force that it was prevented from burning lower than a score of feet from the ground. At that distance it spread out and burst into a violet flame, about twenty feet higher changing to a golden yellow. This huge torch twisted and roared for seven days before a way was devised to extinguish it, and terminate the tremendous waste. This was finally accomplished by the use of steam from six forty horsepower boilers. Four lines of steam pipe were laid from as many sides of the mammoth jet. Saftey valves were tied down, and when the pressure which the boilers were capable of withstanding was reached, the steam was projected on the flow of gas. The mixture of the steam with the gas caused the oxygen to be shut out, and the great flame sputtered, dwindled and finally died out. The well was then capped and brought under control and arrangements are now being made to pipe it to surrounding fields.

CONTRASTS IN MODES AND RATES OF COMBUSTION

By Charles Vickers.

The combination of oxygen with any substance, such as wood, coal or paper, produces a visible effect known as burning, the progress of which is attended with the total destruction of the substance burned and the evolution of light and heat. These visible effects have become so associated with "burning" that it often is difficult to conceive of anything being burned and not producing these effects. When, however, metals, such as iron or copper, combine with oxygen such results are not seen, but the process is that of burning just the same.

When iron rusts at ordinary temperatures there are no visible light or heat effects, although a combination of iron and oxygen has taken place. Heat, however, really is given off, but it is carried away by the air, as quickly as it is formed, and cannot be perceived. This combination of iron and oxygen is really slow combustion, the iron being burned, and in the course of time nothing is left but the ashes, familiarly known as rust, and, as might be expected from the ease with which it is formed, iron ash or rust, is very widely diffused in nature, and is found in most minerals, the ashes of many plants, and the blood of animals. The red, brown or yellow color of many kinds of molding sands is due to the iron oxides which they contain.

Copper and its alloys do not combine with oxygen as readily as iron, and at ordinary temperatures are very enduring. For this reason bronze is used for statues and in exposed positions on the better class of buildings. When copper is brought to a red heat, however, it combines with oxygen and forms copper oxide or rust. Thus, in burning off the insulation from copper wire, a scale is formed which is brittle and is easily detached in the shape of fine flakes or powder. This is copper oxide, and if the wire is again heated and allowed to cool, another layer of scale will be formed, and when the wire becomes very thin it will be found to be oxidized all through, and so brittle that it may be broken with ease. It will also be noted that the scales from the heated copper are of two colors, red and black. This is due to the amount of oxygen that has combined with the metal. The black scales contain the largest amount of oxygen, being composed of one atom each of copper and of oxygen, while the red contains two atoms of copper to one of oxygen, and is produced when the metal cannot get access to sufficient oxygen to form the black protoxide of copper. It will thus be seen that two layers of scale are formed when the metal is heated, the outside one being black, and containing the largest quantity of oxygen, and the inside one red. Both these layers are easily detached by pounding the copper, and before such copper is melted to make bronze, these scales should always be pounded off, because more scale will be formed during the melting process, making it extremely unwise to add any with the metal if it can be avoided.

It will be seen, therefore, that metals can burn, as well as those substances which in the burning give off light and heat. One important difference, however, should be noted, and that is that when wood is burned, the ashes which remain constitute but a very small portion of the original substance, because the greater part has been converted into gaseous bodies, by their combination with oxygen, and have escaped into the atmosphere. The metals, on the other hand, have lost nothing, but have gained in weight, as they have taken oxygen from the air and formed a solid substance, the weight of which has been increased by the added weight of the oxygen with which it is combined.—*The Foundry.*

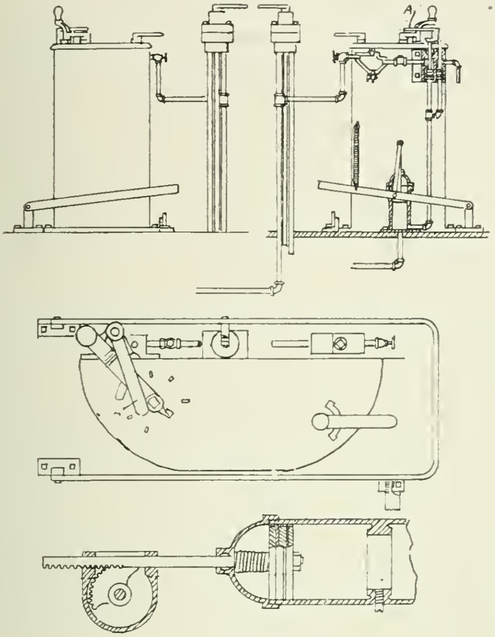


FIG. 1.

AIR OPERATED TROLLEY CAR GATE

There are now in use several different air operated devices for opening and closing the rear gates of trolley cars. The apparatus here shown was designed by Mr. Elmer E. Veley, master mechanic of the Cedar Rapids and Marion City Railway Company, the cuts being adapted from the pages of the Electric Traction Weekly.

The details of the mechanism are shown in Fig. 1. The gate can be operated by the motorman by the air attachments, or on cars without air by means of a foot lever. The air cylinder under the car has two pistons with rods extending out at each end and operating the gates by rack and quadrant. The controller handle and the gate operating handle are so arranged that the motorman cannot apply the power until the gates are closed. He can operate his controller on or off until the car comes to a dead stop when he can release the gates. They do not come together with a slam as they are equipped with a slow regulating device, so that should any one become caught between them no injury to person or clothing will result. In Fig. 3 a boy is caught between the gates and does not seem disturbed by it. The direct connection of the air pistons with the gate quadrants eliminates all lost motion.

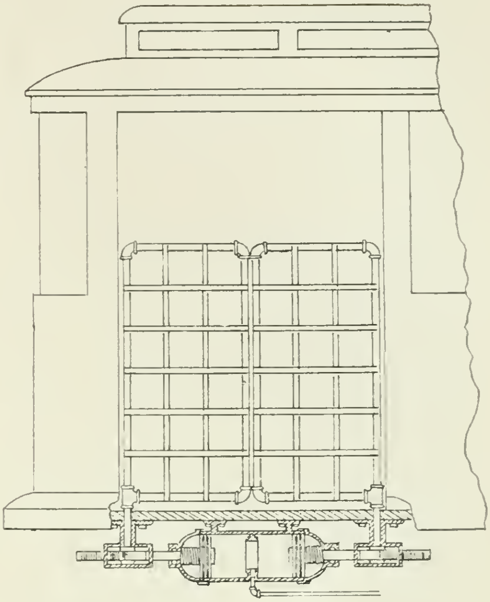


FIG. 2.

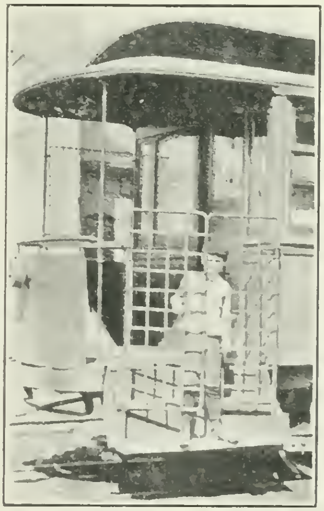


FIG. 3.

CONTROLLABLE DIFFERENTIAL AIR PRESSURE IN SURGERY*

By John B. Huber, A. M., M. D.

Until very recently, the surgeon has paid the thorax deep respect—that cage which imprisons the lungs, the pleura, the heart, and the great vessels; because, while the cerebrum and abdomen contain organs not immediately essential to existence, we should die almost instantly if the heart and the lungs (especially the latter) are put out of action, and because the resilient and elastic lung tissue tends to collapse, on opening the thoracic cavity, under the atmospheric pressure of fifteen pounds to the square inch, to which the surface of our bodies is subjected.

Before 1904, the thorax had indeed been entered, but not safely, unless inflammatory adhesions between the pulmonal and costal pleuræ protected the collapsible lung tissue against the ordinary atmospheric pressure. The surgeon must operate within the thorax as safely as anywhere else within the economy. So surgeons have recognized that such operations as thoracotomy and pneumectomy cannot be done with impunity without the aid of differential air pressure. Much experimentation has been done to this end, with the result that both the lungs and the esophagus may now be safely invaded. The heart may be exposed to view, the pericardium opened and the myocardium incised. All this is not the easiest thing in the world; nevertheless, the skilled surgeon may now proceed with confidence upon operations most hazardous a few year since.

In 1904 there were operating chambers in use in Europe. Brauer's apparatus is a single positive pressure chamber akin to that presently to be described. That of Sauerbruch is a negative pressure chamber, the patient's head being outside of it in the ordinary atmosphere, his body being in the chamber. They were made of metal; voices reverberated in them; surgeon and anesthetizer were separated by a solid wall; the noise made telephoning impossible; the operator could not see his patient's face, there was not sufficient room; there was no provision for breakdown of power; there was negative pressure only, or positive pressure only.

Up to the spring of 1908 the existing apparatus was of two types; one working from atmospheric pressure downward, negative pressure; the other from atmospheric pressure upward, positive pressure. There was none working both ways. Wherefore Dr. Willy Meyer of New York city, and his brother, Mr. Julius Meyer, an engineer, built a double chamber for use in positive and negative differential pressure. It was in this chamber that I saw the whole left lung of a dog removed.

There is an outer negative pressure chamber (the operating room) within which is a positive pressure chamber (the anesthetizer's room). It is thus possible to operate under either negative or positive differential pressure; under a combination of the two; or from one to the other in the same operation.

The advantages of combining two chambers to form one apparatus are: The operating table remains fixed under whatever pressure the operation is done; and there is avoided the moving of the table from inside to outside necessary with the European tables, should it be considered feasible to change the pressure from positive to negative, or *vice versa*. Moreover, in this Meyer chamber there is ample space for the surgeon and his assistants and nurses, arranged for by the projecting head box, in which there is an aperture closed by a rubber collar, adaptable to the size of the neck. The operator can see the patient's face, and the anesthetizer the body—not directly, however, but through a mirror; and attention is, therefore, not distracted from the work of anesthetizing. The anesthetizer and the head of the patient are in the smaller positive differential pressure chamber, which is of size ample for the use of oxygen and other apparatus, and has an airlock providing access and egress while the pressure is on, and without interruption thereof; from this chamber the ether fumes are ventilated off every minute.

The operating chamber needs no air lock. Its pressure can at any time be raised from negative to atmospheric pressure, while the differential pressure required for the operation is being maintained without interruption so that the door leading to the outside can then be opened. A triple reserve is provided in case of breakdown. There are two independently driven sets of pumps—one for pressure, and one for vacuum; so that in case of any mishap to one unit an immediate change

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*Abstract from *Scientific American*.

can be made from one kind of differential to the other; in the event of accident to both units a hand pump is provided, for maintaining the positive differential pressure in the anesthetizing chamber. The motors run at constant speed. The variation of the air pressure in the chambers is effected by manipulations of two air valves, set by hand to the desired gage readings.

This structure belongs neither to the kind of apparatus that works from atmospheric pressure downward, nor to that working from atmospheric pressure upward. It is *sui generis.* The aim in its construction has been to overcome and remove the limitation of differential pressure chambers to atmospheric pressure as the fixed basis at one end of the difference in pressure; and to enable the establishing of the basis anywhere above or below, or at atmospheric pressure, at will. This was accomplished by combining two differential chambers in one apparatus, in which these modifications were possible: (1) The rooms may be separate; (2) they may have one corner in common; (3) or one wall in common.

To what pressure can the operator and his assistants expose themselves? Where is the danger line? Even should the negative chamber be exhausted to a differential pressure of 50 millimeters (1.968 inches) Hg., thus being strained to the limit of its capacity, they would still be within the limits of possible everyday experience; for in our climate barometric fluctuations of 50 millimeters Hg. are nothing unusual. The differential pressures used in thoracic surgery seldom exceed that corresponding to a difference in altitude of from 250 to 300 feet; that is, the patient's mouth is lowered about 300 feet below his opened thorax. However, surgeon, assistants, anesthetizer and nurses are not under differential pressure at all; their entire bodies are under only one pressure.

This combination of medical and engineering science was begun early in 1908. Numerous difficulties were met; on December 23rd 1909, the Universal Differential Pressure Chamber was tested: it was first used in the Rockefeller Institute on January 8th, 1909; on May 7th, 1909, it stood complete.

It may be *apropos* to consider briefly, other contrivances by which atmospheric changes are made for medical purposes. There is the Kuhn pulmonary suction mask, which at two hourly intervals is placed over the nostrils and mouths of sufferers from pulmonary tuberculosis asthma, anemia and certain heart affections, the purpose being to produce a rarefaction of the air in the chest, with a consequent hyperemia. Then there is the pneumatic cabinet, which Dr. C. E. Quimby and other physicians in this city have for at least a decade past been using for pulmonary and cardiac affections. On entering this cabinet one breathes the ordinary atmosphere from without through a rubber tube, while he is subjected to negative pressure. An odd sensation here is that in expiration one has actually to push out the air from one's lungs, and with some little effort. Another is a compressed air chamber, seemingly as large as a fair-sized living-room; there is at least one of these in London, though I do not know of any in New York city.

EXPLOSIVES IN TUNNELING

The selection of explosives for tunnel blasting probably requires a more careful study of conditions than for any other kind of excavating. Maximum speed in driving cannot be attained unless the explosive best adapted to the work is used. When starting a tunnel or drift, it is a good plan to thoroughly try out several explosives which are distinctly different in action, before finally adopting any one of them. The results, however, from this preliminary trial will be of little or no value, unless each different explosive is used under exactly the same conditions. Care must be taken to see that no change occurs in the character of the rock, number and direction of the bore holes, strength of the detonator, kind and quantity of tamping, amount of water encountered, method of connecting up the bore holes for firing, and that the explosive is always thoroughly thawed. If a material change in any of these conditions occurs as the work progresses, further tests should be made to determine whether a quicker or slower, a stronger or weaker, explosive might not break the ground or bottom the bore holes better, or make it possible to bring out the cut with fewer holes or deeper ones. The speed at which rock can be drilled does not indicate how it will break, and not infrequently that which can be easily drilled is very difficult to blast.—*Mining World.*

MACHINES IN COAL MINING

One mining machine with three attendants will generally do as much work as 20 men can accomplish by hand labor. This saving in time, labor and cost has made mining machines indispensable. Every coal-producing State in the Union will eventually enforce laws prohibiting shooting coal from the solid. A machine using a cutter chain traveling horizontally across the face of the coal has the largest capacity and consumes the least amount of power. This style of coal cutter is most commonly used in America and is generally driven by an electric motor. Where a mine has rolling bottom or where a band of sulphur occurs near the bottom of the seam, many chain-breast machines will not work satisfactorily. In such mines, coal-punching machines are most often employed. The puncher machine is also especially adaptable in coal where the cleats are not well defined, as it allows a condition of shooting which places the coal in such a shape that it is easily loaded. Coal always rolls better when shot after being undercut with a puncher. Whether to adopt the chain-breast or the puncher machine at any mine is a question that requires careful consideration.

SAVING BY USE OF MACHINES.

As to the saving that results from machine mining, it may be said that at a mine producing 1000 tons per day and having a 15c margin in favor of machine mining, the gross saving would be about $150 a day, or $30,000 per year of 200 days. In such a case the company can maintain its output with 20 per cent. fewer men than are required when hand mining is employed. The $30,000 saving will pay for the machine plant, installation and cost of maintenance, as well as interest and depreciation, in about one year's time.

The advantages of coal cutting are, (1) an increased percentage of large coal; (2) the coal is mined in a firmer and better condition; (3) a more regular line of face is obtained, leading to more systematic timbering; (4) increased safety conditions for the miner; (5) thin seams can be profitably mined; (6) increased output; and (7) fewer explosives are required for getting down the coal. The effectiveness of machine mining is shown by the fact that American coal operators, with fewer men, produce 60 per cent. more coal than is mined in Great Britain.—*Floyd W. Parsons in Engineer and Mining Journal.*

DIFFERENCES IN STEAM CONSUMPTION OF COMPRESSORS

Suppose that a compressor is required to compress 500 cu. ft. of free air a minute, delivering to a receiver at 100 lb. gage. A two-stage machine of that capacity will require approximately 92 i. h. p. to perform the work. Now, while the best straight line compressors are furnished with Meyer valves, they are usually set by the operator to cut off constantly at about three quarter stroke, and with such setting they will require on an average 45 lb. of steam per horse power hour, while Corliss duplex machines with cross compound steam cylinders will do the work with 15 lb. of steam or less. There is not only thus a saving of two-thirds of the coal consumption, but also a corresponding reduction of boiler plant, and the labor and other cost of its operation.

HYDRO-ELECTRIC POWER FORMULAS

Knowing the quantity of water and satic head in feet, four very simple rules for determining the hydro-electric output of a power-plant have have developed. Three units of water measurement are embodied and the output can, therefore, be calculated direct without conversion.

A miner's inch (m. i.) is taken as 1.5 cu. ft. of water per minute.

(a) 1 m. i. will develop 2 hp. with 1000-ft. head.
(b) 1 min. ft. will develop 1 kw. with 1000-ft. head.
(c) 1 sec. ft. will develop 8 hp. with 100-ft. head.
(d) 1 sec. ft. will develop 6 kw. with 100-ft. head.
(a) Q (miner's inch) × H (feet) × 0.002 = hp.
(b) Q (cu. ft. per min.) × H (feet) × 0.001 = kw.
(c) Q (cu. ft. per sec.) × H (feet) × 0.08 = hp.
(d) Q (cu. ft. per sec.) × H (feet) × 0.06 = kw.

The conversion of kilowatt to horse-power or *vice versa*, can readily be made in the usual manner. The value of these equations lies in the fact that losses such as friction or head loss in the pipe, generator, water-wheel, and transformer losses are all taken into consideration, that is, at the values usual in high-head installations of Western practice.

Assuming a pipe-line efficiency of 95 per cent., a waterwheel efficiency of 80 per cent., a generator efficiency of 96 per cent., and a transformer efficiency of 98 per cent., the plant efficiency is 71.5 per cent. Allowing a still further loss of 1.5 to 2 per cent. for inefficiency in regulating nozzle losses, etc., the switchboard output will be 70 per cent. Assuming well known constants, the following deduction from one of the formulæ may be given:

$w=62.5$ lb. weight of 1 cu. ft. water.
1 hp.$=33{,}000$ ft. lb. per min.
1 m. i.$=1.5$ cu. ft. of water per min.
$Q=$quantity of water.
$H=$static head from forebay to centre of nozzle for impulse wheels and from surface of head-water to tail-water surface in the case of turbines.

From the well known equation $P=QwH$ may be calculated P or hp.$=\frac{1.5\times62.5\times1000 \text{ ft.}}{33{,}000}\times0.70=1.990$, or practically two horse-power, the approximation being large by one-half ot 1 per cent. The other formulae are obtained directly or deduced from the foregoing.

Say that at a certain power house there is continuously delivered 3,500 m. i. of water with a head of 830 ft. Then:

$3{,}500\times830\times0.002=5{,}810$ h. p. or 4,360 kw.

IMPROVED DRAEGER RESCUE APPARATUS

Over 3,600 sets of the Draeger rescue apparatus are now in use in different parts of the world. The experience accumulated has suggested many improvements which have been adopted from time to time, and the inventor has been continually engaged in dealing with practical difficulties the successful solution of which has at last enabled the firm to introduce a new apparatus, which, while retaining all the best features of the old type, embodies many improvements, one of which at least is of a most important character.

In the older apparatus, the length of time a man could work in a noxious atmosphere was limited to two hours, which could possibly be extended to three, by an experienced man husbanding his resources. It frequently happened therefore, that by the time a rescuer had reached the scene of the accident, he was compelled to return, owing to the limited supply of his oxygen. The problem was to construct a smoke helmet with a longer "life" without increasing the weight. Messrs. Draeger have not only accomplished this, but have actually succeeded in reducing the weight. With the new apparatus, it is possible for a man to remain in gas for a length of time only limited by his physical endurance. There are already, we are informed, records of men working continuously in poisonous gases for over seven hours.

REPLACING OXYGEN CYLINDER.

In principle, the machine remains exactly the same. An oxygen cylinder and a potash cartridge is fitted to the frame, which will enable the wearer to breathe in comfort for two hours; instead, however, of having to return to the base to obtain fresh charges, these can be fitted instantaneously with perfect safety in the most poisonous atmosphere. The half tone shows the exchange of oxygen cylinders in smoke in thirty seconds (the breathing will not be affected even if the changing occupies several minutes). No smoke or gas can get through the small capillary tubes of the oxygen-reducing valve The exchanging of the potash cartridge only occupies four seconds. During the time of the exchange, self-acting valves are shutting off the openings in the apparatus and preventing the entrance of noxious gases. Thus it will be seen that by a system of relays bringing up supplies of reserves, teams can work continuously until their object has been accomplished.

Progress has been made not only in efficiency, but also in comfort. The black frame fits the body and the weight is distributed, so that it may be worn without effort. The new helmet is composed largely of soft leather, with a metallic window portion, and the pneumatic lining is of such a shape as to fit any head—long, short, broad or narrow—without undue pressure. The pneumatic rubber lining in this helmet is stronger and safer, and the whole helmet is lighter in weight. The oxygen gauge is carried on the chest, so that the oxygen supply can be watched during work. An important feature of this apparatus is the reduced price of the cartridges.

IMPROVED GAS FOR BALLOONS

A process has been devised in Germany for improving the gas commonly used for balloons. Illuminating gas is forced through long tubes maintained at a high temperature. Most of the carbon is thus separated out and the percentage of hydrogen is largely increased, so that it then constitutes 80 per cent. of the whole. The specific gravity is reduced from 0.44 to 0.225, or less than one-quarter that of air. In coal gas 1 cubic meter (1.3 cubic yards) sustains 0.7 kilo (1.5 pounds). A cubic meter of the new gas sustains 1 kilo (2.2 pounds).

A TROLLEY ROAD WEED BURNER

A home-built weed burner successfully employed by the Northern Texas Traction Company is described in a recent issue of the Electric Traction Weekly. The outfit is mounted on a flat car and it sprays burning crude oil. There are four drums each 20 ft. long and 20 in. in diameter, the upper drum an air reservoir, and the three lower containing crude oil. Air pressure is supplied by a chain driven motor-operated compressor of 105 ft. capacity. A pressure of 150 lbs. is maintained in the air reservoir and a pressure of 80 lbs. goes to the oil drums. The compressor is water jacketed and a water tank is carried over the compressor. There are four burners inside of a drum extending across the track and carried about 3 ins. from it. The drum has a slot at its base and the burners project to the mouth of the slot. Lines from the air drum and from each of the oil drums connect just above each burner and valves are provided in each line to regulate the supply and pressure. By having the burners just inside of the drum the flame is given a whirling effect and spreads it the entire width of the track. Considerable difficulty was experienced in holding the flame down onto the track, and in preventing it from blowing back and setting fire to the car, so that a series of aprons had to be rigged up. The largest of these extends back 6 ft. and is 8 ft. wide, while other aprons protect the car framing and the tanks. The aprons are supported on a pair of T-rails extending the whole length of the car and back to the end of the largest apron. The outfit is trailed by a work car at the rate of 1½ m. p. h. and the work is done at night, 11 p. m. to 4 a. m. During summer months, the line is gone over every two weeks. The cost of operating the rig, including oil, train crew and power, is figured at $125 per month, and as it formerly cost $1,000 per month to dig and cut weeds, besides disturbing the track, the scheme of burning the weeds is looked upon as a very satisfactory investment.

OVERHEATING OF AIR BRAKE PUMPS

Especially in summer the overheating of air pumps becomes a troublesome question alike to enginemen and repairmen. With the initial high temperature of the air on a hot, dry day, added to the heat gained during the process of compression, it requires considerable attention to the air brake system in general to prevent the air pump from being seriously overheated.

Among the most common causes of overheating are: Insufficient lift of air valves, air valves stuck or broken, loose intermediate valve seats cutting off lift or intermediate valves, leak at discharge pipe connection to air pump, or at main drum, air end rod packing blown out and racing of air pump.

These defects are easily located and, if promptly remedied, will prevent overheating and prolong the life and efficiency of the pump.

One defect frequently found is air end rod packing blowing. This reduces the efficiency of the pump to a considerable extent and is sure to result in overheating. This defect is often overlooked, especially if the steam end happens to be blowing at the same time.

Another thing that should not be overlooked in the care of an air pump is its proper lubrication. Do not flood the air end of the pump with oil, especially after it has begun to heat. Do not use engine oil, as it is not suitable for cylinder lubrication and will, in time, choke up the air passages, thereby destroying the efficiency of the pump. Oil sparingly at all times. Keep a good oil swab on the piston rods. Do not make the mistake of speeding the pump, for after a certain speed is attained the pump is working at its full capacity, and crowding beyond that will result only in overheating and failure.

BELT DRIVEN AIR COMPRESSOR

The half tone, Fig. 1, shows one of a line of simple power driven air compressors built by George S. Comstock, Michanicsburg, Pa., suitable for shop use or for any service when compressed air is required in comparatively small quantities and at the ordinary working pressures. Figs. 2 and 3 show the design and construction so that little description is necessary The two cylinders in a straight line and the crank shaft bearings are all integral with the frame or base, so that there is no possibility of are also in a straight line, and the scotch yoke principle employed for the drive gives a practically universal joint at the crank pin brasses. The cylinders are completely water jacketed and the splash lubrication guarantees the constant lubrication of all the working surfaces.

Fig. 3 is an enlarged section of the cylinder head showing the valve arrangement. *D* is the inlet and *E* the delivery. *A* is the inlet valve, and *B* the delivery valve, all being readily accessible. The central cover of the machine can be lifted off at any time giving roomy access to everything inside.

These compressors are made with one, two or four cylinders and with 8 different air capacities ranging from 6 to 140 cubic feet of free air per minute.

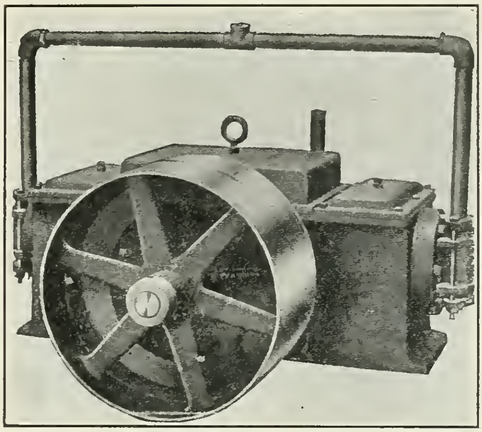

FIG. 1.

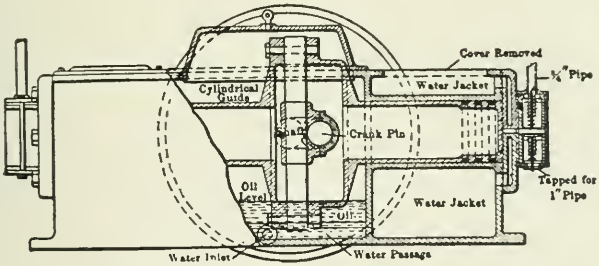

FIG. 2.

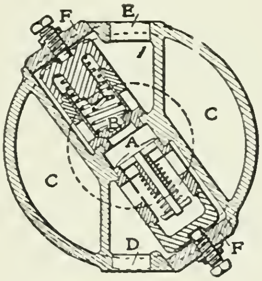

FIG. 3.

A SIPHON WATERWORKS

Siphonic action is the means by which water from fifty 2½ inch driven wells of the Woburn, Mass., supply is conveyed to the pit from which it is pumped into the distribution system. The wells are connected to the pump pit by a 14-in. cast iron pipe, which extends downward almost to the bottom of the latter. The high point in the line where air may collect is tapped by two 2½-in. pipes, which are connected to a closed tank at the pumping station. Air is exhausted from this tank and the pipe line by a small vacuum pump operated by a water-wheel using city pressure, and siphonic action occurs, filling the pipe and tank with water; the air pump is put out of action by a float regulator in the tank as the water rises in it. Air which accumulates during the operation of the siphon enters the tank, and consequently lowers the water level in it; the float, therefore, descends and the air pump is automatically started, exhausting the accumulated air. With this device practically no attendance is necessary.

A GUN'S WORKING LIFE FCUR SECONDS

What is the average working life of a gun? The answer is startling. The useful life of a gun of any size from a .303 rifle to the 13½ in. pieces for the new Dreadnoughts is approximately four seconds! The basis taken for this computation is the number of rounds fired and the time occupied by each round. A 12in. gun is destroyed by erosion after 100 rounds; the average mean velocity of its projectile is half the muzzle velocity, or say, 1200 ft. per second. The length of the gun is 45 ft., and hence its total life 3.8 seconds. As we descend the scale of calibres the number of rounds that may be fired before erosion has destroyed the gun increases, so that the working life remains almost constant at about four seconds. This broad generalisation must not, of course, be taken too literally, as many varying factors may influence the result; but it serves, nevertheless to enforce the fact that the useful life of all guns is actually of the briefest. And the end of all is the same; be they large or small, it is the erosion of the bore that unfits them for further service. But erosion, like some wasting disease, is progressive—it begins with the first round that is fired, and before it has destroyed the sufferer it has greatly reduced its usefulness. The accuracy and range of the gun decrease as the erosion augments, and hence tables and scales, which are correct at the beginning of a fight, are wrong before the action is half over. It is not surprising then that the subject is one that has been profoundly studied, and that new investigations are always being made.—*The Engineer*, London.

A NOVEL STEAM BOILER

A steam boiler and furnace of peculiar construction, which requires no chimney, because the combustion gases are mixed with the steam which is admitted to the cylinders of the steam engine, have been in successful operation for some time on a Russian torpedo boat. Liquid fuel is used, and the combustion gases, which have an initial temperature of from 3,300 to 3,600 deg. F., have a temperature of about 1,800 deg. F. when they leave the heating surfaces of the boiler. The gases then enter a tube into which a fine spray of cold water is injected under pressure. The gases are thus cooled to between 650 and 900 deg. F., and the water is converted into superheated or unsaturated steam of the same temperature. The mixture of steam and combustion gases is conducted into the upper part of the boiler and flows thence, mixed with steam generated in the boiler, to the cylinders. In addition to dispensing with the chimney, the new boiler possesses the merit of very high efficiency, utilizing 90 and even as much as 97 per cent. of the heat produced by the combustion of the fuel.

PNEUMATIC CAISSONS FOR DRY-DOCKS IN QUICKSAND

The dry-dock construction in the Brooklyn navy yard is one of those complicated pieces of work which deserve to be described by a literary master like Kipling, for the struggle that is going on there between the treacherous quicksand and the men in charge of the work is something wholly outside the ordinary run of engineering undertakings. Every dry-dock in the yard has caused its builders constant worry, but the new one has a particularly cantankerous record of disaster. Those who are unacquainted with the site can hardly imagine the difficulties. The place is underlaid by very fine material possessing most of the characteristics of quicksand, although some engineers have hardly classed it as such. Whenever a large excavation is made in it subsidence occurs in the vicinity. The earlier contractors on the dock conducted the work in the open, and before they retired a number of buildings in the vicinity were injured by the settlement of their foundations. Attention has been called from time to time to the warning against such methods given years ago by the builder of the first dry-dock in the yard, the late William J. McAlpine. His experience showed him that it was impossible to execute more than a small piece of the structure at a time, but that the concrete could be put in piecemeal by concentrating the work on small areas. The new dock, after a long record of disappointments and tribulations, is now being executed in just this way, but by means which were outside the resources of Mr. McAlpine. The construction of such a dock is essentially a foundation problem, and the work is now being executed successfully by employing that most important resource of foundation specialists, the pneumatic caisson. This is essentially a means for concentrating construction on a small area under the most favorable conditions, and the work in progress in the Brooklyn navy yard is a singularly vivid exemplification of the progress in such matters since the first dock was constructed. That the troubles have by no means been wholly overcome is very probable, but enough of them have been encountered and bested to indicate that the new dock can be constructed without any more serious results to adjacent structures.—*Engineering Record.*

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

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PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. SEPTEMBER, 1910. No. 9

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STONE QUARRYING TO SPECIFICATION

In comparing the rate of production of a modern manufacturing establishment in almost any line of activity with that of one of the shops of the olden time, with its obsolete means and methods, the comparison always being of course for the magnification of the former, we are apt to omit some of the essential particulars, the omission leading us to unwarranted conclusions. A locomotive works, for instance, for a given force employed, will now turn out many times the number and value of engines which would have been possible half a century ago. Upon investigation it will soon appear that all the improvements in machine efficiencies and in the details of shop manipulation do not nearly account for the vast increase in output. Every shop in these days not only has its own force busily employed, but it also has many hands in many factories variously situated producing the minor details of the assembled machines which it turns out. Besides the enumerated force of workmen in the shop itself, there are probably many more than that number in other shops who are preparing material and manufacturing the numerous "supplies" which the shop requires and uses to complete its work.

This same distributing and specializing of activities, while concentrating their results, applies in larger enterprises than those of the shops. The greatest of all industries, is the building of cities, and none, perhaps, has had a greater transformation. The modern building methods are most rapid and prolific, because here the practice is now similar to that of the shops. The building of New York, for instance, is going on, not in New York alone, but in various places throughout the land. Practically all the vast structures which we are continually piling up higher and higher are really manufactured elsewhere, Manhattan witnessing only the final assembling of the parts. Most of the building of the skyscraper is done at the steel works, and at the stone quarry, and the several pieces, whether of steel or of stone, come already fitted and marked and numbered, to show how they go together.

In machine work, and all through the metal industries, the automatic screw machine, which as we all know, turns out a vast variety of small machine parts besides screws, is perhaps the greatest individual helper, and in stone work the channeler finds equally wide employment, and accomplishment no less prolific.

The channeler emphasizes perhaps more completely than any other device the difference between ancient and modern practice in stone work. The channeler is not as yet capable of working some of the harder stones, but in the vast field which it does cover it represents the cutting of stone to precise dimensions.

We are quite in the habit of saying that Egyptian architecture called for massive blocks of stone, but the simple fact is that the method of quarrying produced big stones and the architect was compelled to adapt his designs to the material as it came to him. The quarries of Egypt even to-day tell clearly the story of the splitting off of the stones by the cutting of rows of holes of no great depth and the swelling force of the wooden blocks which tightly filled them. It is often said that we could not now get out and transport the stone masses of ancient Egypt. It simply would not pay and would not be worth while for us.

If we could not reproduce the temples of Thebes, still less could the builders of Thebes have produced the Metropolitan Life Building of New York, the largest marble structure in the world, and the most complete embodiment of the work of the channeler. After the Tuckahoe marble was decided upon for the material, the quarry could in no other particular dictate to the architect. The blocks in shape, dimension and detail of decoration were determined in the office, and the drills and channelers and pneumatic tools produced them precisely as ordered.

PNEUMATIC CAISSONS FOR RAISING THE MAINE

Mr. John F. O'Rouke, of the O'Rouke Engineering Construction Company of New York, has proposed to the War Department an application of pneumatic caisson methods for the raising of the Maine in Havana harbor. He proposes to raise the vessel in its entirety so that its holes can be patched and the ship be floated out of Havana Harbor. The scheme consists in sinking pneumatic caissons on both sides of the sunken vessel and between wharves previously constructed at the site. The caissons would be carried to a depth of about 10 feet below the bottom of the ship and through them steel cables of about 200 tons capacity would be passed at distances of 4 feet and carried beneath the hull of the vessel. The ends of these cables would be attached to screw jacks of at least 100 tons capacity, and by their operation, the vessel would be lifted from the bottom. The scheme for passing the cables beneath the hull is quite ingenious. The heavy lifting cable would be passed down through one caisson and immediately opposite each of these lifting cables, in the other caissons, a three-quarter-inch hauling cable would be placed. Small pipes would then be pushed through the bottom from one caisson to the other and through these the ends of the small cables would be passed to the opposite air chamber, after which the pipe would be pulled into that air chamber over the ends of the cables, leaving the latter exposed in the mud. The ends of the big cables would be attached to the smaller ones, hauled beneath the vessel and up to the top of the opposite caissons. By placing the lifting cables at distances of 4 feet, Mr. O'Rouke estimates that their combined strength would be four times the weight of the battleship. The framework supporting the lifting jacks would be built on the caissons, and, in order to prevent an excessive weight being thrown onto the foundations of the latter when the vessel is lifted, it is proposed to pump out the cofferdams above the caisson, thus making them buoyant. As the vessel is lifted it will be necessary, of course, to lower the jacks, in order to give them a new grip on the cables, and for this reason Mr. O'Rourke has provided a greater capacity than necessary, so that the jacks can be slacked off in pairs. He estimates that at least a thousand men would be required for operating the jacks.

ELECTRICTY vs. COMPRESSED AIR

Electrically operated construction equipment is steadily gaining in favor among contractors. It will be observed, however, that small electrically operated tools are rarely employed, for electricity is generally used simply as a convenient method of transmitting power from a source of supply of either permanent or temporary character to an air-compressor plant. Of course, electric hoists, electric railways and electrically driven machine tools are a frequent feature in construction camps, but small equipment, such as rock drills, churn drills, pumps and similar equipment, are still preferably operated by compressed air, in the opinion of most contractors. The reason for this is not far to seek. Construction equipment is subjected to a most grueling service. Dirt is present everywhere, often in the form of fine mud or very dry sand, the men in charge of the apparatus are generally unskilled laborers without sufficient intelligence to handle mechanism with delicate parts, and the location and maintenance of wiring, although apparently simple, has repeatedly proved a very troublesome matter, particularly on account of grounds. On the other hand, compressed-air machinery is as sturdy as anything made to-day. It has been developed by men who know all about its uses, and its operation is watched by their representatives for the express purpose of detecting every opportunity for improvement. The piping and connections can be made readily, and the average workman can keep them in condition more easily than electric wiring.—*Engineering Record.*

COMPRESSED AIR FOR HANDLING WET CONCENTRATES

At Cananea, Mex., the wet concentrates from the Cananea Consolidated mill are loaded into small, narrow-gage railroad cars and transported to the main ore bins. From these bins they are fed to a belt conveyer which passes through the sampling works to the mixing beds.

A simple device has been introduced, as described by Mr. M. J. Elsing in a recent issue of The Engineering and Mining Journal, which greatly reduces the cost and the labor of handling this wet material. From the jarring and the settling received in the railroad cars, the wet concentrates become so firmly packed that even after the bottom of the car has been released, the concentrates will not fall from the car. Formerly it was necessary for two men to do considerable barring in order to dislodge the concentrates and empty the car. A compressed-air device is now used which saves all barring.

The device consists of a 1¼-in. pipe, approximately 9 ft. long, with a short piece of pipe attached which is pointed at one end with a hole in it about ¼ in. in diameter. The short piece is attached with an ordinary pipe coupling. At the other end of the long pipe there is a valve attached and an ordinary air hose. This is then connected with an air main under a pressure of from 80 to 90 pounds.

With this device a Mexican stands on each end of the railroad car, thrusting the pointed end well toward the bottom of the loaded car, and turns on the air. The result is that with a small amount of barring with this device the car is quickly unloaded. The concentrates are literally blown out. Formerly it took from one to 1½ hours to unload a train of from six or seven cars. It is now done in about 15 to 20 minutes.

The device is again used in feeding the concentrate from the steel bins to the belt conveyer. A steady feed is obtained with the expenditure of only a small amount of air and labor.

FREEZING OF PUMP EXHAUSTS

The exhaust of a pump operated by compressed air will not ordinarily freeze if the air outlet be of large size, but often pumps which have been designed for operation by steam are connected with the compressed-air line in the mine, and such pumps are more than likely to freeze at the exhaust. This can be prevented if the main water-discharge column be tapped about 10 ft. above the pump and a ¼-in. pipe be inserted, this small pipe to be extended to the air exhaust of the pump, and the end of the pipe drawn down to about one-sixteenth inch. The jet of water from this little nozzle should be directed into the exhaust opening, when it will be found that the exhaust will not freeze. In some cases it is sufficient to allow the stream of water from the little pipe to merely drip down on the exhaust port of the pump.

With the best modern compressed air practice, where aftercoolers are provided near the compressors, with separating chambers farther along the line where the water dropped by the air may collect and be drawn off, the freezing of pump exhausts is practically unknown.

CAPACITY OF THE HORSE

Endurance is the horse's weakest point. Ten hours a day is often assumed as his working period. Authorities claim that eight hours is better, or that six under a heavier load will accomplish the same volume of work with less tear and wear on the horse. The average farm horse cannot be depended upon for more than 13 to 15 miles of pull a day, nor more than four to six hours of work per day, as an average of even the busiest months. Properly handled working about six hours a day, well and carefully fed, a horse may have a working life of ten years of 1,000 hours each. The average farm horse will do well to develop 500 horsepower hours per year or 5,000 in ten years. About 20 per cent. of the horse's weight may be taken as his maximum sustained draft, and six to eight miles per hour his maximum sustained speed for anything more than an hour or so per day. The draft horse ordinarily gives the largest volume of work per day at about one-half his maximum load, and one-third his maximum speed.

BUREAU OF MINES

The new Bureau of Mines, of the Department of the Interior, will devote itself first and principally to the investigation of mine accidents, a work which has heretofore been carried on under the Geological Survey. For this purpose and for the investigation of fuels, Congress appropriated $410,000, and the total appropriation for the Bureau is $502,200. In general, the Bureau will continue the work of the Technologic Branch of the Geological Survey, and the work will be done largely by the same men heretofore engaged in the work. Many of the problems before the Bureau will have to wait, however, until Congress makes further appropriations. The director of the Bureau is George O. Smith. Bulletins on analyses of coal and other subjects will be issued by the Bureau before long. The director's office is at Washington, but the Bureau includes the testing station at Pittsburg, and resue stations will be established at a number of points in the coal regions.

MINING TUNNEL SCHEMES

As an investment, long tunnels driven solely for the purpose of cutting unknown veins or veins of unknown depth which outcrop at the surface, are rather risky undertakings, the chances for losing being far greater than those for winning. Veins that look promising at the outcrop may be found to have narrowed at depth or pinched out entirely. It would be far more profitable to sink on them than to do a great amount of dead work until their value and permanence has been proved. Driving in the hope of cutting unknown veins is absolute folly. Such schemes may appear plausible to the inexperienced, when presented by a silver-tongued promoter, backed by maps and sketches of underground conditions as they exist in his imagination only. It is a safe rule to let such schemes alone.

This does not apply, however to another class of tunnel schemes, where the primary object of the tunnel is not to cut veins, but to afford main haulage roads communicating with an important proved mineral area and to provide a cheap means for taking out a large tonnage of ore, or to afford drainage for a large number of mines. Such tunnels are the Newhouse, Yak and Roosevelt in Colorado, the Sutro in Nevada, etc. Tunnels of this kind may disclose valuable ore bodies which can be opened through them, and prove sources of profit, but this is merely incidental. There is no gamble in such undertakings, as the benefits to be expected from them can be closely estimated before the work is undertaken.—*Mining World.*

AN IMPROVED ANEMOMETER

A new form of anemometer for recording separately the components of the wind motion in two fixed rectangular directions, such as the north-southerly and the east-westerly, is described by J. T. Morrison in the proceedings of the Royal Society of Edinburgh. The novel feature of this instrument is a sphere, mounted on a horizontal axis, the latter being moved in a horizontal plane by a wind vane so as to lie always parallel with the direction of the wind. The sphere is connected, by suitable gearing, with a wind wheel exposed to the wind, and rotates with it, its rotation corresponding to the total movement of the wind. The latter is analyzed into two components by means of two beveled discs, mounted on vertical axes, and pressing the sphere at their edges, so as to be turned by it with speeds and directions varying according to the position of the sphere. The center of one disc lies east and that of the other north of the center of the sphere. The discs actuate separate pens that trace curves making a continuous record of the two rectangular components of wind-movement.

CONSULTING A DIVINER TO AVOID WATER TROUBLE

An interesting application of the water diviner's art has been made at Daggafontain, where the services of Mr. Collyer, the expert, have been employed to indicate the spot on the property where the proposed shaft would be least likely to suffer from water troubles.

Throughout the whole Far East Rand basin water is giving trouble, and the experience of the Grootvlei people, where many thousands of gallons per day have had to be dealt with, points to the necessity for doing everything to avoid the underground springs which seem to abound in the neighborhood. On the Daggafontain Mr. Collyer has indicated a spot where a shaft, in his opinion will be free from all but ordinary soakage water, and should his prediction be fulfilled no doubt his assistance will be invoked as a preliminary to shaft sinking on other properties in water carrying districts.—*South African Mining Journal.*

LACK OF OXYGEN IN HYDRAULIC AIR AT COBALT

When the air from the hydraulic air compressing plant at Ragged Chutes, Cobalt district, Ontario, was first turned on it was found that it was practically impossible to burn candles in the mines where it was used. It was claimed that this was due to the absorption of oxygen by the asphalt with which the inside of the pipes were coated, and that this effect would soon pass off. It was soon found, however, that hydraulic air contains an appreciably less percentage of oxygen than ordinary air, and analysis demonstrated that it contained only 17.7 per cent. oxygen, which is 3 per cent. lower than ordinary air. This is due to the oxygen going into solution in the water during compression, when a pressure of 130 to 135 lb. per sq. in. is maintained. The lack of oxygen does not apparently trouble the miners, but besides the difficulty experienced in keeping lights, the effect of the gases from exploded dynamite is much quicker and more serious than was found to be the case with air compressed by machinery.—*Engineering and Mining Journal.*

USINC ANEROID BAROMETERS

Aneroid barometers possess peculiarities which must be known for each instrument in order to employ them with safety. Without such knowledge even the indicated difference of altitude between two near-by points, which may be reached before temperature and moisture conditions in the atmosphere can have changed, is not to be trusted. Each instrument is generally reliable within certain limits of altitude, one being safe at low levels, another at moderate elevations, and so on. No aneroid barometer should be used for serious reconnoissance leveling until it has been thoroughly tested under partial vacuums corresponding to the atmospheric pressures at different elevations above sea level. No aneroids possess a constant error throughout the range of pressures they are supposed to record. Furthermore, the errors once determined will not apply throughout the life of the instrument, this being due apparently to gradual relief of strain between the molecules in the corrugated metal plate. If an aneroid can be tested against mercurial barometers within the limits of altitude in which it is intended to work, it is better than to trust to the air pump.

NOTES

The Lehigh Valley is to tunnel Bear Mountain at Mauch Chunk at an expense of $1,000,000. A short cut of one mile is now to be gained.

Explosive mixtures of alcohol vapor and air can be compressed to much higher pressures in an engine cylinder without pre-igniting than can explosive mixtures of gasoline vapors and air.

In California it has been demonstrated that in thermal units two and a half barrels of oil equals one ton of coal. Coal costs there from $6 to $8 per ton wholesale, while the market delivery price of oil is $1 a barrel.

The Prussian State Railways have recently installed an apparatus in which a complete coach can be heated by steam and subjected to a vacuum, with the object of drying it, and destroying vermin. The process occupies about ten hours, and costs approximately $5.

On the Denver and Rio Grande Railroad recently an entire train, locomotive and eight cars, going at a high speed left the track and ran along for a distance on the ties without anything turning over or anybody being hurt by even a scratch. Near the place is a bridge where a hundred lives were lost a few years ago.

The short but dangerous rock tunnel of the Jersey Central at Glen Onoko is to be removed by blasting away the entire mountain cliff of stratified rock through which it was built. The cost of the work will be about $1,000,000 and is considered preferable to building a bridge over the river, which would probably be fully as expensive and is the only way in which the road could get around the mountain.

Commissioner Moore's recommendation that that section of the patent statutes which provides for the filing of caveats be repealed, has been acted upon by Congress and the President. Henceforth there will be no more caveats in the United States. An application for a patent does all that a caveat can do, and more.

And now the aeroplane has come down to carrying freight. A. M. Williams, an aviator of Douglas, Arizona, has contracted to convey placer mining machinery from Douglas to the property of Dr. J. J. P. Armstrong in the mountains of Chihuahua, Mexico, a distance ot 300 miles, the route being practically inaccessible for teams. Pieces or packages weighing up to 100 pounds are to be carried.

At the foundry of the Fort Wayne Electric Works rain water in a closed piping system is circulated through the water jackets of the air compressors by a plunger pump driven from the compressor shaft, replacing a constant flow of city water. The circulation starts when the compressor starts and stops when it is shut down. Tubular automobile radiators keep the water cool.

As a matter of cold fact, pending patent applications are the only valid excuse for withholding from publication the description of anything new. When there is no element of this kind involved a manufacturer's attempt at secrecy almost always indicates either that he is pitiably small-minded and conceited or that he is afraid to submit his designs to the critical consideration of the engineering public.—*Power and the Engineer.*

In California there are many large dredges in use costing as high as $150,000 to $300,000. The average life of these dredges, which seems to be determined by that of the hull, is from eight to ten years, while if proper means are not employed for the prevention of dry rot a hull will go to pieces in four or five years. On a dredge of the Natomas Consolidated of California, operating in the American River field, artificial ventilation is being tried. Air is forced into the hull by a fan blower, starting at one end, the intermediate hatches being battened down so that circulation is secured throughout the entire length.

In the scientific sense an ore is a metalliferous mineral belonging to the group of those which have profitably yielded the metals to the miner or metallurgist. In its technical sense an ore is a metalliferous mineral or an aggregate of metalliferous minerals, more or less mixed with gangue and capable of being, from the standpoint of the miner, won at a profit; or from the standpoint of the metallurgist, treated at a profit.

Juan Antolin, a Spanish laborer, aged 38 years, was washed through 269 ft. of 20-in. drain pipe at Gatun Dam on the afternoon of July 4, and is recovering from the bruises he sustained. He was one of a gang at work on a floating platform keeping debris, from the hydrauic fill in the west section of the dam, from being carried into the drain pipe and clogging it. He fell from the platform and, although his fellow workers tried to rescue him, was carried head first into the pipe. A minute later he was washed out of the discharge end of the pipe into the old West Diversion channel whence he swam and was dragged ashore.—*The Canal Record,* July 13, 1910.

The Knox system of blasting is used in quarrying, and consists in drilling two holes in the rock, these holes being located along the line where a fracture is desired, and about 1 foot apart. Black powder is charged in the hole, the quantity being determined by the size of the rock mass it is desired to split off. Tamping is put in the hole, but is not placed in contact with the powder, a space of 1 to 3 feet being left between tamping and powder. This affords an air cushion, which in part receives the shock of the blast. The holes are fired and recharged several times the result being the fracture of the rock along a line corresponding to the direction of the holes.

A young woman student in the Engineering Department of the University of Michigan, announces that she intends to make a specialty of sewer contracting. She says: "Why shouldn't there be just as much opportunity for a girl to win success building sewers as in writing stories, teaching school, doing sociological work or lecturing on woman's suffrage." We wish her all success, but she may find that the qualification requirements are quite different in sewer constructing from those in the other avocations she specifies.

Boilers may be, and in fact have been, hydraulically tested for pressure without the use of a pump. The cold boiler must be filled completely with cold water, leaving no air anywhere. Then build a small fire under the boiler, not to generate steam but just to warm the water. Its expansion will immediately begin to cause pressure, which will show at the pressure gage. When the test pressure is reached open a try cock and if everything is all right the water may be discharged at the blow-off until it is at the proper level for raising steam.

Calypso's Island has been moved to South Bethlehem, Pa., by dredging it out of the center of the Lehigh River by direction of the engineering staff of the Lehigh Valley Railroad, and the material, 125,000 cubic yards of stone and earth, has been used to fill in an arch-like curve that the right bank of the river makes just west of South Bethlehem. The object of the removal of the island is to straighten the road and to get space for four tracks in addition to room for building sidings.

Compressed air for cleaning the electric machinery in all parts of the filtration building of the Cincinnati water purification works has been made available by the installation of a motor-driven compressor and a small air receiver in the pump room of the head-house. From the receiver a 1-in. pipe line, with suitable outlets, was run through the pipe gallery of the filter house and into the chemical house. A flexible hose attached to outlets on the line permits the electric equipment to be cleaned readily.

To ascertain the weight of dust contained in a given volume of air, a chloride of calcium tube containing perfectly dry absorbent cotton is weighed accurately and then attached to a water suction pump with an air meter between. A large amount of air, say, 18 or 20 cubic feet, is then drawn through as quickly as possible, and when a sufficient amount has passed, the tube is detached and placed either in a drying oven or in a desiccator over sulphuric acid, and kept until it ceases to lose weight (moisture). After this operation the net increase in weight represents the amount of dust in the volume of air aspirated.

The French government has finally decided not to adopt aluminum coinage. A certain number of aluminum coins were made as a test, but the lightness of the white metal, which was one of its chief recommendations, has condemned it. A five-centime piece (one cent) made of aluminum weighed only 1.9 grammes, as against 5 grammes in bronze, and it is thought that a coin so light would slip through the fingers, especially the rough fingers of a workman. Tests are now to be made of bronze containing 10 per cent. of aluminum, which, if adopted, will reduce the weight by one-half. This combination of metals possesses a fine golden yellow colour, and the coins made of it will therefore be perforated so that they may not be mistaken for 20-franc pieces.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

JULY 5.

963,049. APPARATUS FOR REMOVING DUST. David T. Kenney, North Plainfield borough, N. J.

963,139. PNEUMATIC SUCTION-CLEANER. Daniel D. Griffiths, New Madrid, Mo.

963,244. PROCESS OF STERILIZING MILK. Cassius Clay Palmer, Cranford, N. J.

963,359. WIND-TURBINE. Joseph Gershom Childs, Willesden Green, London, England.

963,407. EGG-SHELL REMOVER. Anton Uhlir, Charleston, W. Va.

2. In an egg-shell remover, in combination, a chamber for receiving one portion of an egg, means to perforate the shell thereof and means to compress air in said chamber.

963,465. AUTOMATIC RAILWAY AIR-BRAKE. William K. Omick, Detroit, Mich.

963,487. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE APPARATUS. Walter V. Turner, Edgewood, Pa.

963,606. PNEUMATIC SHOCK-ABSORBER. Albert Mans, Dieghem, Belgium.

963,641. DEVICE FOR PUMPING LIQUIDS. Frederic H. Parke, Edgewood, Pa.

963,662. AUTOMATIC CONTROL FOR PRESSURE APPARATUS. Henry F. Thoma, Sand Coulee, Mont.

963,676. AIR - COMPRESSOR. William Wright, Adamsville, Ala.

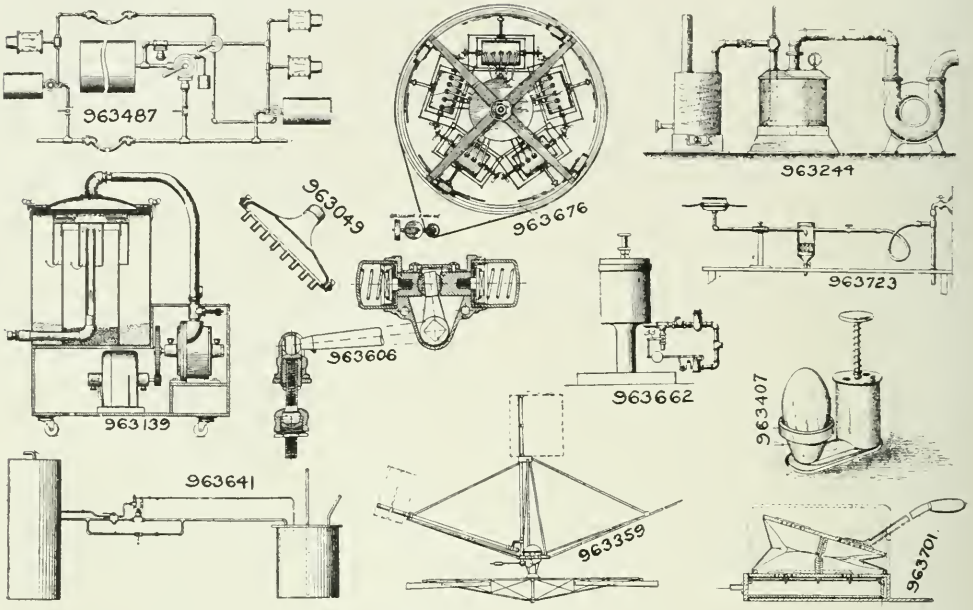
963,701. VACUUM-CLEANER. Eric Ericsson and Eric G. Thoreen, Worcester, Mass.

963,723. VACUUM CLEANING APPARATUS. Edward Wallace Pierce, Philadelphia, Pa.

JULY 12.

963,767. METHOD OF CLEANING AND STERILIZING FILTER-STONES. HAROLD JARVIS, Buffalo, N. Y.

3. The herein described method of cleaning a water filter stone which consists in forcing air through the pores of said stone from the delivery side to the supply side thereof while the latter side is immersed in hot water and then drawing said hot water through the pores of the stone from the supply side to the delivery side thereof.



PNEUMATIC PATENTS, JULY 26.

963,759. VACUUM-PAN APPARATUS. JOHN A. GROSHON, New York, N. Y.

963,787. MINE-VENTILATING SYSTEM. DAVID R. MARTIN, Opelika, Ala.

963,788. AIR-COMPRESSOR. FRANK HEATH MERRILL, Plainfield, N. J.

963,803. COMBINED GOVERNOR AND REGULATOR FOR AIR-COMPRESSORS. JOHN L. OSBORNE, Erie, Pa.

963,829. HUMIDIFYING APPARATUS FOR DWELLING-HOUSES. ALBERT W. THOMPSON, Manchester, N. H.

963,832. APPARATUS AND PROCESS FOR CONTROLLING HUMIDITY OF GASES IN DRYING OPERATIONS. HARRY D. TIEMANN, Washington, D. C.

963,923. AIR-PUMP. GEORGE MCKERAHAN, Altoona, Pa.

963,924. ATTACHMENT FOR PNEUMATIC HAMMERS. CHARLES MCSHERRY, Pittsburg, Pa.

963,973. PROCESS FOR INTRODUCING MODIFYING ELEMENTS INTO CASTINGS. FRANK G. WRIGHT, Indiana Harbor, Ind.

The process of introducing a modifying element into a cast body during pouring into the molds which consists of directing a blast of air containing the element in the form of a powder in a downward direction into the stream of heated metal as it enters the mold.

963,981. AUTOMATIC PNEUMATIC MUSICAL INSTRUMENT. ERNEST WILLIAM BATTEN, Herne Hill, London, England.

964,013. PNEUMATICALLY - OPERATED STRING INSTRUMENT. ROBERT FROMSDORF, Leipzig-Eutritzsch, Germany.

964,049. PNEUMATIC TIRE. MILTON T. J. OCHS, Allentown, Pa.

964,168. CONTROL DEVICE FOR AIR-BRAKE MECHANISMS. CAMILLE LANG, Wilmington, Del.

964,373. CAR-VENTILATOR. ALFRED BEST, Salt Lake City, Utah.

964,377. AIR-FILTER. WALTER BLASS, Essen, Germany.

JULY 19.

964,485. FLUID-BRAKE. FRANZ BOMINGHAUS, Essen-on-the-Ruhr-West, Germany.

964,492. OXYGEN-GENERATOR. MONROE S. CLAWSON, New York, N. Y.

964,574. MEANS FOR INCREASING THE ENERGY OF STORED COMPRESSED AIR. WILLIAM HORACE SODEAU, Newcastle-upon-Tyne, England.

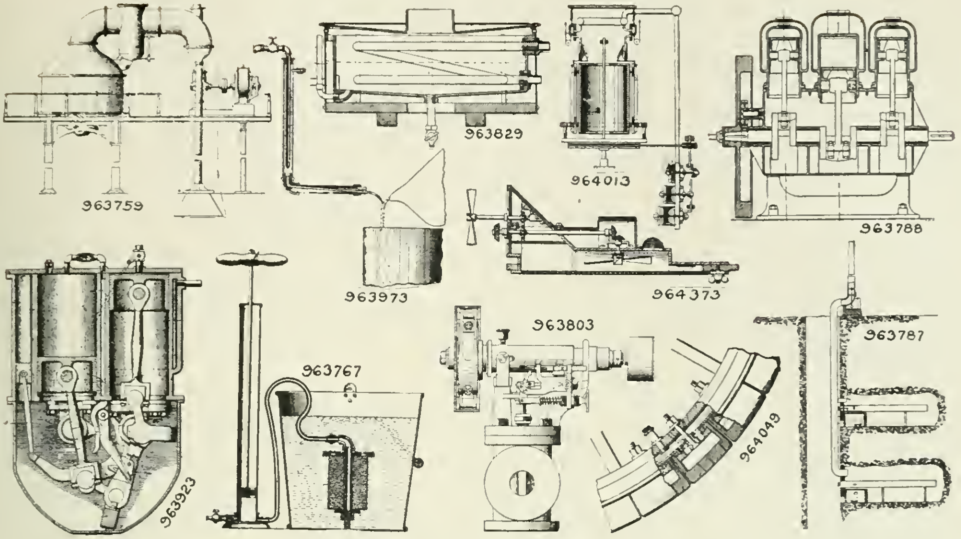
1. Means for increasing the energy of stored compressed air comprising in combination a combustion chamber, a conduit leading compressed air to said combustion chamber, a receptacle for liquid, means leading from said receptacle to said combustion chamber and means connecting said receptacle with the compressed air conduit, said means having an opening in the conduit facing toward the oncoming air whereby the kinetic energy of the air stream in the conduit produces a pressure in the liquid receptacle in excess of that in the air conduit and combustion chamber.

964,605. FEEDING MECHANISM FOR ROCK-DRILLS AND THE LIKE. GEORGE R. BENNETT, Denver, Colo.

964,639. PNEUMATIC CLUTCH. JAMES C. GARRETT, Jersey City, N. J.

964,717. PROCESS OF SEPARATING DUST AND OTHER MATERIALS FROM DUST-LADEN AIR AND A DUST-COLLECTOR FOR CARRYING OUT SAID PROCESS. CHARLES F. VERRELL, Grand Rapids, Mich.

964,771. AEROPLANE. SAMUEL H. GILSON, Salt Lake City, Utah.



Pneumatic Patents, July 19.

964,800. SUCTION-NOZZLE. Jacob C. Luden, Reading, Pa.

964,805. APPARATUS FOR PRODUCING CEMENT. Hermann Passow, Blankanese, Germany.

964,866. FLUID-PRESSURE MOTOR. Roy C. Jenner, Detroit, Mich.

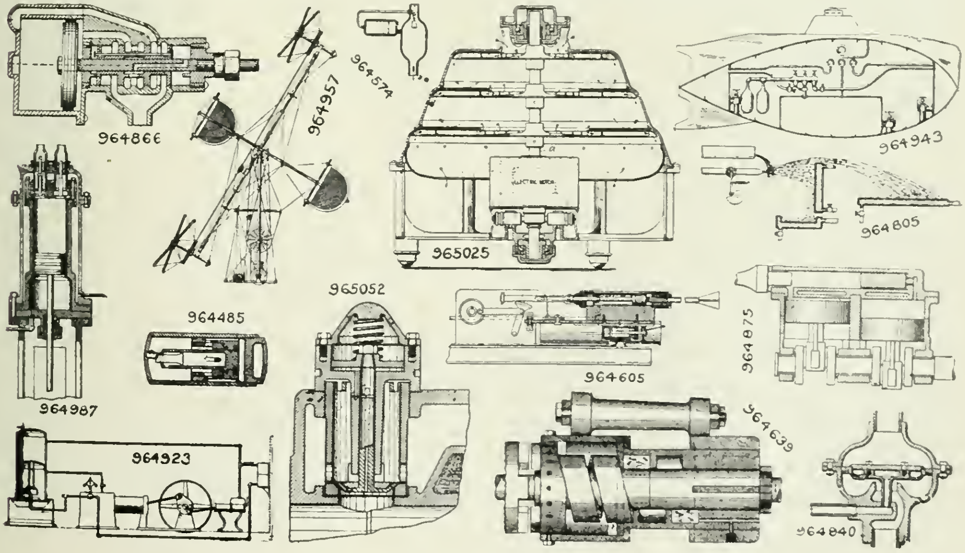
964,875. ROCK-DRILL. Harry Johan Hjalmar Nathorst, Gellivare Malmfalt, Malmberget, Sweden.

964,921. AIR-HEATING SYSTEM. Simon S. Laughlin, Colwich, Kans.

964,923. POWER-GENERATING APPARATUS. Frank W. Lierman, Milwaukee, Wis.; Augusta Lierman, executrix of said Frank W. Lierman, deceased.

A pressure-fluid generator comprising an upper and a lower chamber, the upper one being an air chamber and the lower a combustion and expansion chamber, means for supplying air to said air chamber, a burner in the lower part of said combustion chamber, means for supplying fuel to said burner, a hood overhanging said burner, a connection between said hood and said air chamber adapted to direct a blast of air upon said burner, and an outlet in said combustion chamber at a point remote from said burner, for the mingled air and products of combustion.

964,940. DUST-SEPARATING OR VACUUM CLEANING APPARATUS. Lemuel William Serrell, Plainfield, N. J.



Pneumatic Patents, July 12.

964,943. MEANS FOR EMPTYING SUBMERGENCE-TANKS IN SUBMERGIBLE BOATS. Lawrence Y. Spear, Quincy, Mass.

1. In a submarine or submergible boat, a plurality of submergence tanks including tanks discharging under high pressure and tanks discharging under low pressure, a single fluid pressure system connected to the several submergence tanks for expelling the water therefrom, and means for indicating the pressure in each tank, whereby danger of exploding the low pressure tanks is avoided, substantially as described.

964,957. FLYING-MACHINE. Halvor Olsen Eiane, U. S. Navy.

964,987. COMPRESSOR. John T. Love, Charlotte, N. C.

965,021. FLYING-MACHINE. Hans Schouboe, Omaha, Nebr.

965,025. VACUUM-PRODUCING APPARATUS. Lemuel William Serrell, Plainfield, N. J.

965,052. COMPRESSOR AND VACUUM-PUMP VALVE. Charles Wainwright, Erie, Pa.

965,120. GOVERNOR FOR AIR-COMPRESSORS. Gory O'Bryan, Louisville, Ky.

means of compressed air, the combination of an air compressor and a compressed air motor connected together in a closed circuit, an engine for driving said compressor, a crank shaft for said compressor, a valve shaft for said compressor, a valve for said compressor connected to said valve shaft, and manually operable means for varying the angular relation of said valve shaft and said crank shaft and thereby varying the time of movement of the valve.

965,310. PNEUMATIC STACKER. Wallace F. MacGregor, Racine, Wis.

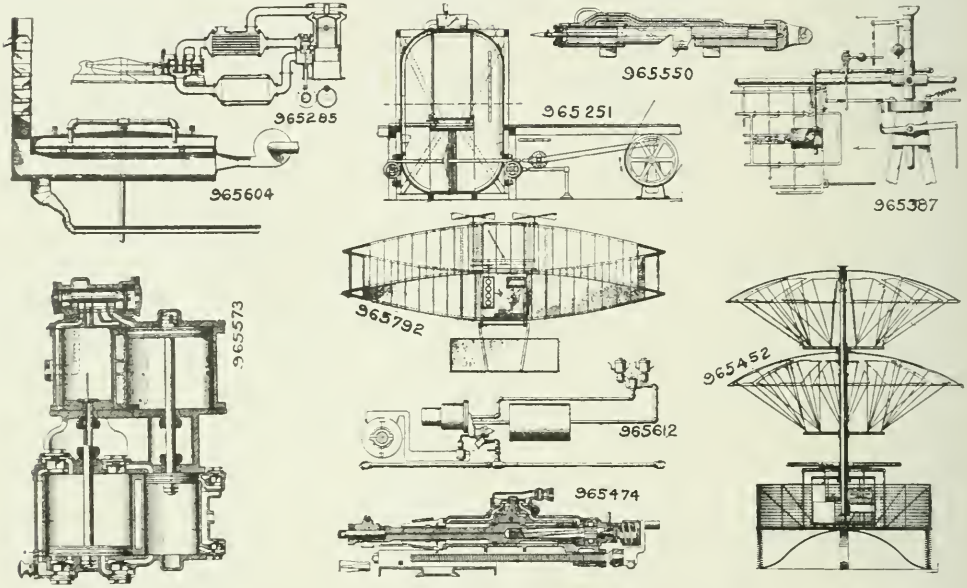
965,387. WINDMILL. Henry I. Hawxhurst, Los Angeles, Cal.

965,452. FLYING-MACHINE. Fred Lincoln Gould, Reno, Nev.

965,474. ROCK-DRILL. Edwin M. Mackie and Percival F. Doyle, Franklin, Pa.

965,494. SENDING-TERMINAL FOR PNEUMATIC-DESPATCH-TUBE SYSTEMS. Franklin H. Wolever, Chicago, Ill.

965,550. AUTOMATIC TOOL-OPERATING DEVICE. John M. Abrams, Bentley Manor, N. Y.



Pneumatic Patents, July 5.

JULY 26.

965,208. SURF COMPRESSOR APPARATUS. John Levering Matthews, San Diego, Cal.

965,251. PROCESS OF DRYING GOODS. Ludwig von Susskind, St. Georgen, near St. Gallen, Switzerland.

2. The herein described process of drying moist substances consisting in compressing air in a closed chamber containing the substance to be dried, dividing the volume of air into two streams according to the degree of dryness required, causing one stream to pass through the substance to be dried and causing the other stream to follow a parallel path and to overcome an adjustable resistance, regulating the temperature and dryness of the second stream, and reuniting the said streams.

Chicago, Ill.

965,281. PNEUMATIC TIRE. John Corwin,

965,285. APPARATUS FOR TRANSMITTING POWER. James Dunlop, Dennistoun, Glasgow, Scotland.

1. In apparatus for transmitting power by

965,573. COMPOUND STEAM PUMPING-ENGINE. Alexander England, Wilkinsburg, Pa.

2. In a compound pumping engine, the combination with high and low pressure engine cylinders having pistons therein, of an initial compression pump cylinder having a piston directly connected to the high pressure steam piston, a smaller final compression pump cylinder having a piston connected to the low pressure steam piston, and a valve mechanism operated by the movement of the high pressure steam piston for effecting the admission and exhaust of steam to and from the engine cylinders.

965,604. PASTEURIZED-CREAM COOLER AND AERATOR. Edwin S. Snively, Omaha, Nebr.

965,682. AIRSHIP. Leonidas Hamlin Barringer, Charleston, W. Va.

965,612. DUPLEX AIR-BRAKE SYSTEM. Walter V. Turner, Edgewood, Pa.

965,783. VACUUM CLEANING APPARATUS. Theodore Wiedemann and Joseph H. Templin, Philadelphia, Pa.

965,792. AEROPLANE. Louis R. Adams, New York, N. Y.

COMPRESSED AIR MAGAZINE

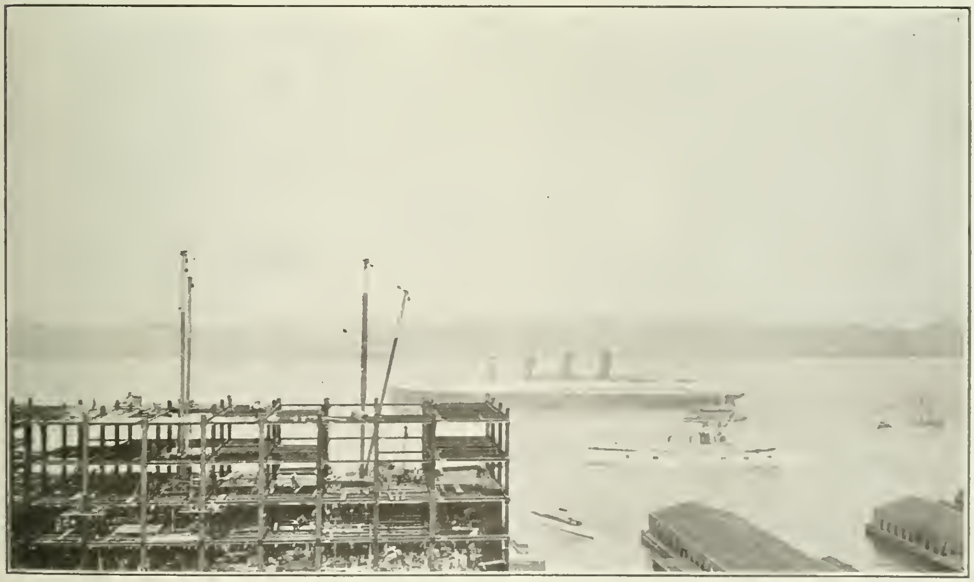
EVERYTHING PNEUMATIC.

Vol. XV OCTOBER, 1910 No. 10

THE LATEST AND LARGEST OFFICE BUILDING

An interesting, but to us not an altogether welcome event, of the summer just passed, has been the running up of the latest of the great office buildings of New York before the editorial window, thus partially shutting off our view of the North River and its endless flow of busy craft coming and going. The building is at present known as the Annex to the Whitehall Building. In the picture on the following page, Fig. 2, from the architects drawing, the smaller building—it is only twenty stories—at the right, which looks down the Bay, is *the* Whitehall Building, and the larger, is the Annex Building, its front facing the North, or Hudson River. Our snapshots Figs. 1 and 3, taken from our fourteenth story window, show the rear of the building.

This structure is one of the many trophies of modern architecture—and we may say also of modern manufacture—to the possibility of whose erection pneumatics has been one of the chief and most necessary contributors. Situated so near the river, the sinking of the caissons through the loose and pervious sand down to the rock was quite comparable to working in an actual diving bell. It was not only necessary to secure foundations for each of the steel columns to carry the great weight of the superstructure, but the entire area of



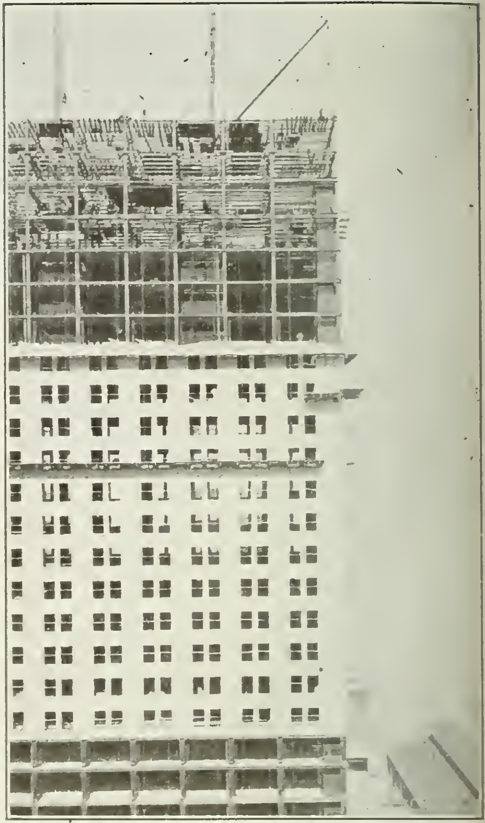
CUTTING OFF OUR OUTLOOK.

the basement stories, sides and bottom, were to be made watertight and also strengthened to resist the lateral and upward pressure due to the submerged depth.

After the erection of the steel framework began we had the din of the pneumatic riveters all day long. The speed with which the steel frame went up would have been marvelous only that such feats are now the habit. Fig. 3 was taken only three weeks after Fig. 1. While the steel work was going up the walls and flooring crowded along as fast as the opportunity developed. It will be noted that the walls, of light colored brick, begin at the eighth story, the stories below being of stone could be erected later, all being supported by the steel structure within and the old time function of the walls as the support of the building being entirely ignored. As the building is seen in Fig. 3 there were still five stories to be added to complete the height, while several stories are out of the view at the bottom, so that to have got them all in we should have had a panoramic camera, using it vertically.

THE WHITEHALL BUILDING AND ITS ANNEX.

The Annex is built upon a plot of 51,515 square feet. It is 31 full stories, 415 feet, above the street level and its total cubic capacity is 11,000,000 cubic feet. There are 14,000 tons of structure steel, 7,500,000 of common brick, 900,000 face brick and 3,000 tons of ornamental terra cotta. Within the building there will be 450,000 square feet of partition tile and 120,000 square feet of column covering, 45,000 barrels of cement being used. For the floors there will be 800,000 feet of yellow pine and 80,000 feet of base molding. The boiler equipment of the building will be 21,000 horse power. Space will not permit an enumeration of the mechanical, electrical and miscellaneous equipment.



BUILDING PART WAY UP.

Butte men won the Ryan $1,000 prize at Calumet, Michigan, July 30 by drilling 53½ inches in granite in 15 minutes. This sets up a new world's record for double-hand drilling, surpassing that of 48¼ inches made at El Paso, Texas, in 1904.

PNEUMATIC CAULKING OF LARGE GAS MAINS

A new and highly satisfactory employment of compressed air operated tools has developed in connection with the laying of a large main crossing the Harlem River, New York, by the Consolidated Gas Company. The pipe is 48 inches in diameter and is laid in a deep trench, as seen in the halftones. The most onerous operation in connection with the laying of such lines as this has hitherto been the caulking of the joints. This has been done by hand, and it has usually been a slow operation, delaying all the work, and the results after all have lacked uniformity and reliability. The most frequent defects have been at the under side of the pipe on account of its inaccessibility. For a single joint of this size two hours and a half were required for the yarning and seven hours for the laying and caulking of the lead wool, or a ten hour day's work of two men for each joint. Three and a half inches of tarred rope was rammed in for the yarning, and this was followed by the lead wool which was finally packed to two and a half inches, using 160 pounds of lead to the joint.

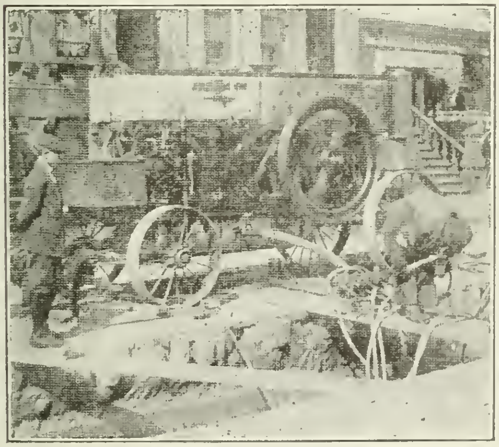


FIG. 1.

When pneumatic hammers were put on the job the same proportion of yarn and lead wool were at first used, but under these hammers the lead was packed so much more tightly that 187 pounds of lead wool was required to fill the same space before filled with 160 pounds. The space allowed to be filled with the lead wool was then reduced to 2¼ inches and about 16 pounds was then used, as with the hand caulking.

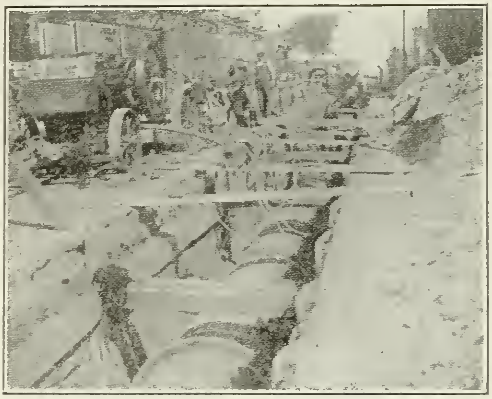


FIG. 2.

The yarning process is still done by hand, and two men are employed on the caulking as before, one on each side. It has become an easy matter to caulk the bottom of the joint, and a uniform packing and tightness is secured all around the pipe.

The labor saving possibilities of these tools as applied to this work are readily seen when the results of this limited trial show that two joints are completely yarned and caulked by two men in a ten hour day, against one joint in the same time by hand.

Ingersoll-Rand Crown Hammers No. 53 were used for this work. These had round bushings which permitted the piston to turn to follow the curve of the pipe without requiring the holding of the drill body in inconvenient positions. The halftone Fig. 1 shows the Ingersoll-Rand portable compressor used, driven by a 15 H. P. Abenaque Gas Engine. A manifold is seen at the edge of the trench to which eight hammers can be connected, so that four joints may be caulked at once. The engine consumes 10 gallons of gasoline a day, or a gallon an hour, maintaining an air pressuresure of about 60 pounds. The halftone was reproduced from Progressive Age. It was found inconvenient to show the tools actually at work upon the pipe.

The function of this gas main is to connect Manhattan and the Bronx, so that it of course crosses the Harlem River, being laid in a deep trench prepared for it under the water. It is especially necessary that this portion of the line should be tight, not only on account of its absolute inaccessibility but also because the water pressure so much exceeds that of the gas, and water might leak into and accumulate in the pipes. The sections of pipe here rest upon concrete blocks and are held in position by wedges at the sides. In placing the pipe two lengths were placed together and caulked on the deck of the barge and then lowered into position when the alternate joints were packed and caulked by divers. For this work Imperial hammers were found more suitable.

HIGH PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS

[The following article by Mr. J. William Jones, Painted Post, N. Y., we are enabled to reproduce by the kind permission of the editor of *Machinery,* in which it first appeared, the cuts constituting the August contribution to the valuable series of Data Sheet Supplements regularly accompanying that publication. The entire matter is copyrighted by the Industrial Press of New York.]

The charts or diagrams on pages following are intended for the rapid determination of the proper diameters of high pressure cylinders for two stage air compressors. By means of these charts it is possible to find instantly the required high pressure cylinder diameter for various pressures and altitudes, when the low pressure cylinder diameter is known, the latter being determined, usually, by the volume of free air to be compressed in a given time.

Fig. I is taken up with condensed instructions as to the methods of using the charts which follow. The first of these charts, Fig. II, is laid out for sea level conditions. The diameter and stroke of the low pressure cylinder are first computed with reference to the required piston displacement, and from this diameter the high pressure cylinder diameter is traced as shown for a single case by the dotted lines and arrows on the chart. These show the method of procedure when the diameter of the low pressure cylinder is 20 inches and the air is compressed to 200 pounds gage pressure. Any ratio between the cylinder diameters found in this way divides the load equally between the two stages, provided the intercooler abstracts all the heat due to the compression in the first stage. The two other charts are laid out for 5,000 and 10,000 feet altitudes, and are otherwise used in the same manner as the first chart.

A problem which often confronts the compressor builder when manufacturing a standard line, is to obtain cylinder ratios which will be approximately correct for various conditions. As an example, assume that it is required to determine the dimensions for the high-pressure cylinder of a compound compressor having a low-pressure cylinder of 30 inches diameter. It is required to find the correct cylinder ratios for 80 to 100 pounds gage pressures for altitudes from sea level up to 5,000 feet. Referring to the sea level chart we find that the proper diameter of the high-pressure cylinder for 80 pounds would be 18 7-8 inches, and for 100 pounds, 18 inches. On the 5,000-foot altitude chart we find that the high-pressure cylinder at this altitude should be 18⅛ and 17¼ inches, for 80 and 100 pounds pressure, respectively. A convenient mean of the above pressures would be 18 inches diameter, which would meet the requirements of the case very satisfactorily.

A table of abstract ratios of compression for various pressures and altitudes is given in Fig. I, with all necessary instructions as to the use of the charts. As a final example, assume that a given compressor requires a low pressure cylinder 33 inches diameter, and that it is required to find the high pressure cylinder diameter for compressing air to 100 pounds, gage, at sea level. The operation will be as follows:

$$d = \sqrt{\frac{33^2}{\sqrt{\frac{14.7 + 100}{14.7}}}} = 19.75 \text{ inches.}$$

This calculation is somewhat lengthy, and the charts here given will be found very convenient in such cases in that they give the diameter directly without any calculation.

In the Newcastle, England, district in 1909 the total of coal cut by electrical coal cutters was 468,067 tons, and by compressed air 767,114 tons, there being in use 45 electric machines and 178 air machines.

HIGH-PRESURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—I.

Method of Using the Accompanying Charts.

The diameters of high-pressure cylinders for compound air compressors are found instantly from the accompanying charts for varying pressures and altitudes, when the low-pressure cylinder diameter and the stroke have first been computed with reference to the required piston displacement. The dotted lines and arrows in the diagrams indicate the procedure when the diameter of the low-pressure cylinder is 20 inches and the air compressed to 200 pounds gage pressure. The ratio between the cylinder diameters so found divides the load equally between the two stages, provided the intercooler abstracts all the heat due to compression in the first stage.

The ratios of cylinder areas in the charts are obtained from the absolute ratio of compression.

Example: Compression of 150 pounds gage pressure required.
Absolute pressure = 150 + 14.7 = 164.7 pounds.
Absolute ratio of compression = 164.7 ÷ 14.7 = 11.2.

The square root of this ratio is the ratio of the low-pressure piston area to the high-pressure piston area, or

$$\sqrt{11.2} = 3.35 = \text{ratio of cylinder areas.}$$

A table of absolute ratios of compression for various pressures and altitudes is given below:

Table of Absolute Ratios of Compression.

Gage Pressure, Pounds.	Absolute Ratio of Compression		
	Sea Level	5000 feet	10000 feet
80	6.44	7.55	8.92
100	7.80	9.20	10.90
125	9.50	11.25	13.40
150	11.20	13.30	15.90
200	14.60	17.40	20.80
250	18.00	21.50	25.80
300	21.40	25.60	30.70

The general formula for determining the high-pressure cylinder diameter is:

$$d = \sqrt{\frac{D^2}{\sqrt{\frac{P_1 + P_2}{P_1}}}}$$

in which d = diameter of high-pressure cylinder,
D = diameter of low-pressure cylinder,
P_1 = initial pressure,
P_2 = terminal gage pressure.

WHY THE DRIED BLAST PAYS.

BY PROF. JOSEPH W. RICHARDS, SOUTH BETHLEHEM, PA.

The higher maximum temperature of the furnace gases in the smelting zone (region of the tuyeres) is the sole and the sufficient reason for the advantages produced by drying the blast. Removing the moisture of the blast results in saving the heat formerly required for its decomposition, and enables the furnace gases to attain a higher maximum temperature of combustion. The higher maximum temperature of the furnace gases quickens the rate of transfer of the necessary smelting heat to the slag and pig iron, and thus increases the rate of smelting.

The smelting down of slag and pig iron to the liquid and superheated state requires to have added to those materials, at a temperature at and above their melting points, their latent heats of fusion and the sensible heat of superheated liquid material. This is the principal thermal work done in the smelting zone of the furnace. It can only be accomplished by the agency of furnace gases possessing maximum temperatures far above the melting points of these materials, and is accomplished only by the sensible heat which these gases are able to give out in cooling down from their maximum temperature to the melting points of the slag and iron.

THE GAIN IN EFFECTIVE SMELTING HEAT.

The sensible heat which the furnace gases possess above the melting points of the slag and iron is therefore the only effective smelting heat which they possess, and is a direct measure of their smelting capacity. Any rise in the maximum temperature of the furnace gases increases in a large proportion the part of their sensible heat available above this necessary smelting temperature and thus increases largely their smelting power. When the smelting power of the carbon burned in the tuyere region is increased, more iron and slag can be smelted per unit of carbon there oxidized, and therefore the fuel consumption in the smelting zone is greatly decreased per unit of pig iron produced. This decrease of carbon consumption in the smelting zone does not necessitate the use of more carbon for reducing purposes in the upper part of the furnace, because there is ordinarily produced in the smelting region by the oxygen of the blast such a large excess of CO gas that only a small fraction of it can be possibly used up in reducing the ore. The poor ratio of CO^2 to CO in the gases of the ordinary furnace is not due to imperfect reduction of ore by CO, but to the fact that such a great excess of CO gas is formed in the tuyere region that the oxygen of the ore can only convert a small fraction of this CO into CO^2.

The smaller amount of carbon consumed in the tuyere zone when using dried blast is therefore more perfectly changed into CO^2 in the upper part of the furnace, during the reduction of the ore, and therefore gives greater thermal service in the furnace per unit of carbon consumed. This improvement in the ratio of CO^2 to CO in the throat gases is a direct result of the smaller carbon requirement in the smelting region.

The smaller amount of carbon consumed per unit of pig iron, or of burden charged, results in a smaller volume of CO and N^2 gases rising through the furnace per unit of burden. They therefore perform reduction more thoroughly, and become cooler before leaving the furnace. While, therefore, the smelting zone is working hotter, the upper part of the furnace works cooler. Since the furnace works faster, the radiatrix and conductrix losses per day being no higher or even less than before, these losses expressed per unit of output become lessened. Since less blast is required per unit of product, the stoves can heat it hotter and the blowing engines have less work to do, unless the blast is kept constant and the output increased to its maximum. In any case, the blowing engine power per unit of output is decreased.

REGULARITY AND UNIFORMITY.

Besides these direct results of the higher temperature in the tuyere region, there are secondary advantages of removing or rendering uniformly low the moisture in the blast, which are of great value to the management of the furnace. These are the regularity of running, of output, of fuel consumption and of grade of pig iron produced. The manager does not have to fear sudden changes in the quality of iron produced, nor to carry an excess of fuel in the furnace charge in order to

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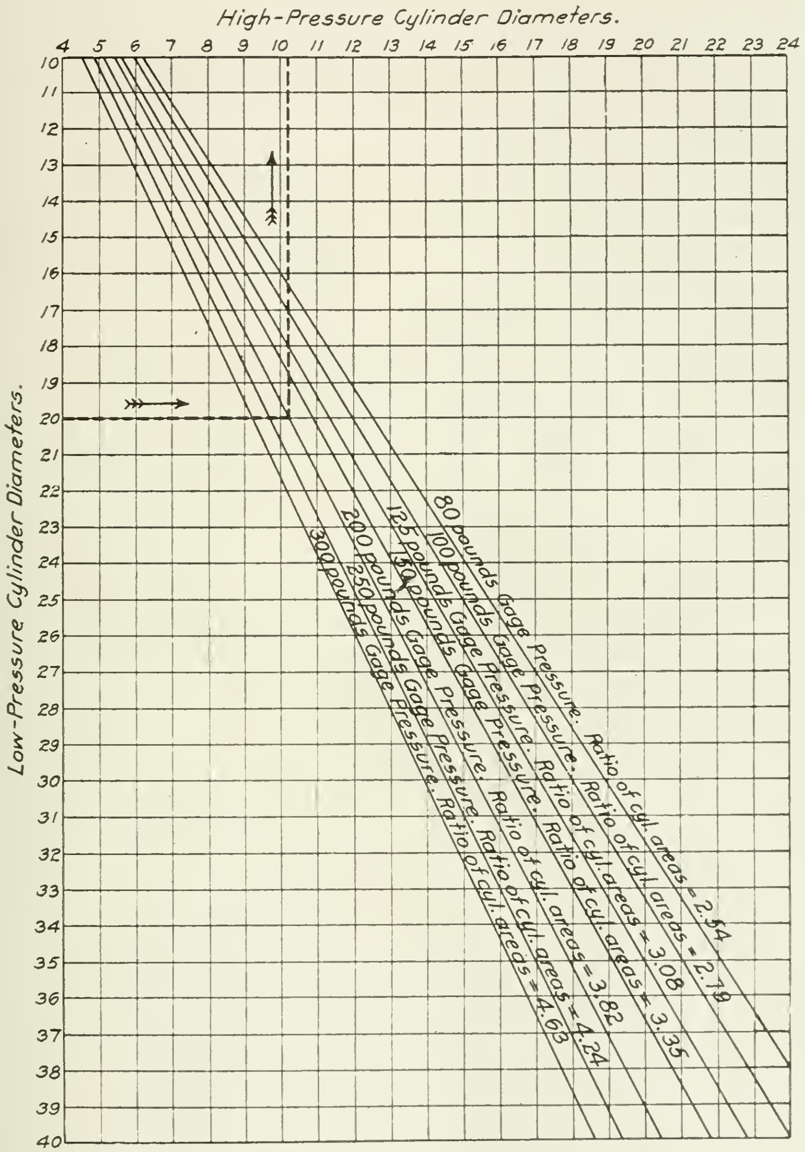
*A paper read at the International Congress of Mining and Metallurgy, Dusseldorf, Germany, June, 1910.

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—II.



Compound Air Cylinders for Sea Level Compression.
Atmospheric pressure 14.7 pounds per square inch.

provide against such unforseen changes. This regularity gives such great relief to the manager that the practical man may well count it as the chief advantage, as far as he is concerned of using the dried blast.

But uniformity and regularity are only one side of the advantages of dried blast; the other side is the economy resulting directly from the absence of high moisture and the consequent high temperature in the tuyere region. Regular and uniform running at high efficiency is the combination which in its entirety has made such a great advance in practical blast furnace running with dried blast.

REASONS FOR INCREASED OUTPUT

With dry air blown upon incandescent carbon, the maximum temperature of the gaseous products of combustion, CO and N^2, will be 1678 degrees for cold blast, and 84 degrees hotter for every 100 degrees that the blast is heated. With moisture present in the blast, these temperatures may be reduced as much as 235 degrees when the air is warm and saturated with moisture, giving a theoretical maximum temperature of only 1,443 degrees with unheated blast. Details of these calculations, and tabulation of temperatures for various atmospheric conditions and temperatures of blast may be found in the writer's "Metallurgical Calculations," Part II, pp. 282-286. As an illustration, if the outside air carries 40 g. of moisture per cubic meter and the blast is heated to 500 degrees, the maximum temperature of the gases of combustion in the tuyere region is 1,848 degrees; while if the moisture is reduced to 5 g., and the blast temperature is unchanged, the maximum gas temperature rises to 2,061 degrees.

Assuming a smelting temperature of 1,250 degrees as required while melting is being performed, the first case gives an excess, or temperature head, of 598 degrees, available to transfer heat to the charge as it is being smelted; the second case gives an excess of 811 degrees, or an increase of temperature head of 213 degrees, or 36 per cent. Under these conditions, the furnace would smelt down charge approximately 36 per cent. faster with the dried blast than with the moist. Admittedly, these atmospheric conditions are extremes: The average increase on the Atlantic Coast of the United States has been 15 to 20 per cent. for the year's running. The three blast furnaces producing the largest number of tons of pig iron in 1909 in the United States were all three running on dried blast.

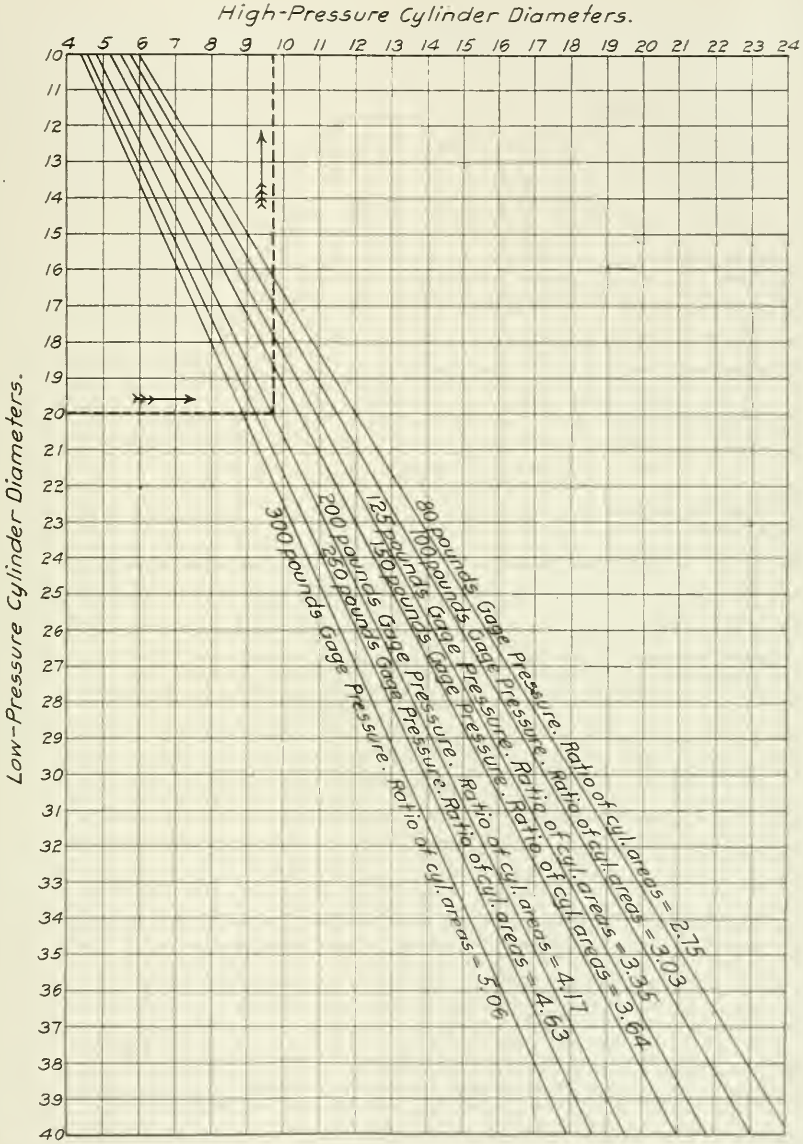
The increased smelting power per unit of carbon burned in the tuyere region, when using dried blast, is also calculable. When a kilogram of carbon is burned to CO, it evolves 2430 calories; if the blast necessary is preheated, there is added to this the sensible heat in the blast. The total available smelting heat per kilogram of carbon, using dry air blast, can be thus calculated:

Temperature of blast.	Available heat.
0 degrees	2,430 cal.
300 degrees	2,847 cal.
600 degrees	3,286 cal.
900 degrees	3,746 cal.

If, however, moisture is present, it rapidly absorbs heat and reduces the available heat in the smelting region. Its effect is, therefore, to leave less heat available at a lower initial maximum temperature. Taking again the example of blast at 500 degrees and air with 40 g. of moisture to the cubic meter, the total heat available is 3137 calories from combustion and the blast, diminished by 574 required to decompose the water vapor, leaving only 2563 calories available. The calories available for smelting purposes in the tuyere region is thus decreased 18 per cent. by the presence of the moisture. Remove this moisture, and the weight of carbon necessary to be burned in the tuyere region to do a given amount of smelting work will be reduced 18 per cent.: *i. e.*, the fuel requirement of the furnace will be reduced at least 18 per cent., calculating per unit of output. Other incidental advantages will increase the saving even above the calculated 18 per cent.

If less carbon is burned in the tuyere region per unit of output, the oxygen from the solid charges given out by reduction, and which is fixed in amount, will produce a relatively greater proportion of CO^2 in the issuing gases. This means that a greater proportion of the CO formed will be converted into CO,^{2}, and therefore a greater utilization in the furnace of the calorific power of the carbon of the fuel. For example: If in a given furnace 75.3 kg. of carbon is burned at the tuyeres to CO, producing there 175 kg. of CO, and the solid charges give up in being reduced 41.8 kg. of oxygen, this can convert 73.15 kg. of CO into CO^2, and the total heat of oxydation of the carbon to this proportion of CO and CO^2 can

HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—III.



Compound Air Cylinders for 5,000 feet Altitude Compression.
Atmospheric pressure 12.2 pounds per square inch.

be calculated as 6119 calories per kilogram of fixed carbon consumed. If, by using dried blast, 18 per cent. less carbon is thus consumed (giving, however, just as much available heat in the tuyere region and 61.75 kg. is burned to CO, producing 144.1 kg. of CO, 73.15 kg. of this will be likewise converted into CO^2 by the 41.8 kg. of oxygen from reduction (producing just the same amount of heat in the upper part of the furnace) and the total heat of oxydation of the carbon to this proportion of CO and CO^2 can be calculated as 6928 calories. The carbon burned in the furnace is therefore utilized with some 13 per cent. greater thermal efficiency when using the smaller quantity in the tuyere region required by the dried blast.

Similar calculations could be made as to the smaller velocity with which the smaller amount of cooler gas passes through the upper part of the furnace, and the consequent better utilization of its reducing power and of its sensible heat in heating the descending charges. Analogous calculations could be made showing quantitatively the smaller radiatrix and conductrix loss per unit of product, when using dried blast. The data for such calculations are, however, not as abundant or as trustworthy as those already used. A longer experience with dried blast in practice will enable these data to be also used quantitatively, with convincing results.

A PNEUMATIC SPOTTER

The following we have strained out of a newspaper reporter's story:

There was many a stop, many a shudder and many a wondering look yesterday among the passengers who passed the ticket choppers of the Hudson Tunnel entrance in Hoboken. No one knew he was being experimented on and the several passengers who did not shudder thought some one had touched them on the arm. The passengers were being counted by compressed air, and the counter ghost was keeping tabs on the ticket chopper, who wore a worried look.

Counting by compressed air is achieved through the continued flow of air from a pipe rising from the ground about three feet. This stream of air flows horizontally against two diaphragms. When nobody passes and the air is flowing, the diaphragms do not touch, but as soon as there is an interruption to the stream the two delicate diaphragms meet and through an electrical contrivance the device registers the interruption. The pipe is about an eighth of an inch in diameter, and the temperature of the air flowing from it is about 70 degrees. Not only can the figures be recorded in the ticket office, but an arrangement can be made whereby the central office gets the approximate count of all passengers at the time they pass the ticket chopper.

In the test it was noticed that while the passengers were entering the station slowly the counter worked accurately. But when two persons passed close together only one fare was marked up by the counter, as there was only one interruption of the air current. When that happened the ticket chopper was seen to smile, but sadness was on the ticket chopper's face when a small boy stood before the stream of compressed air, and, clapping his hand against it, managed to register about a dozen fares before the ticket chopper could stop him.

One old woman who thought the ticket chopper had called her passed by the stream of air in going back, and then, when she found she was mistaken, passed on again. She registered three fares and would have struck up another if the conductor had not waved her back.

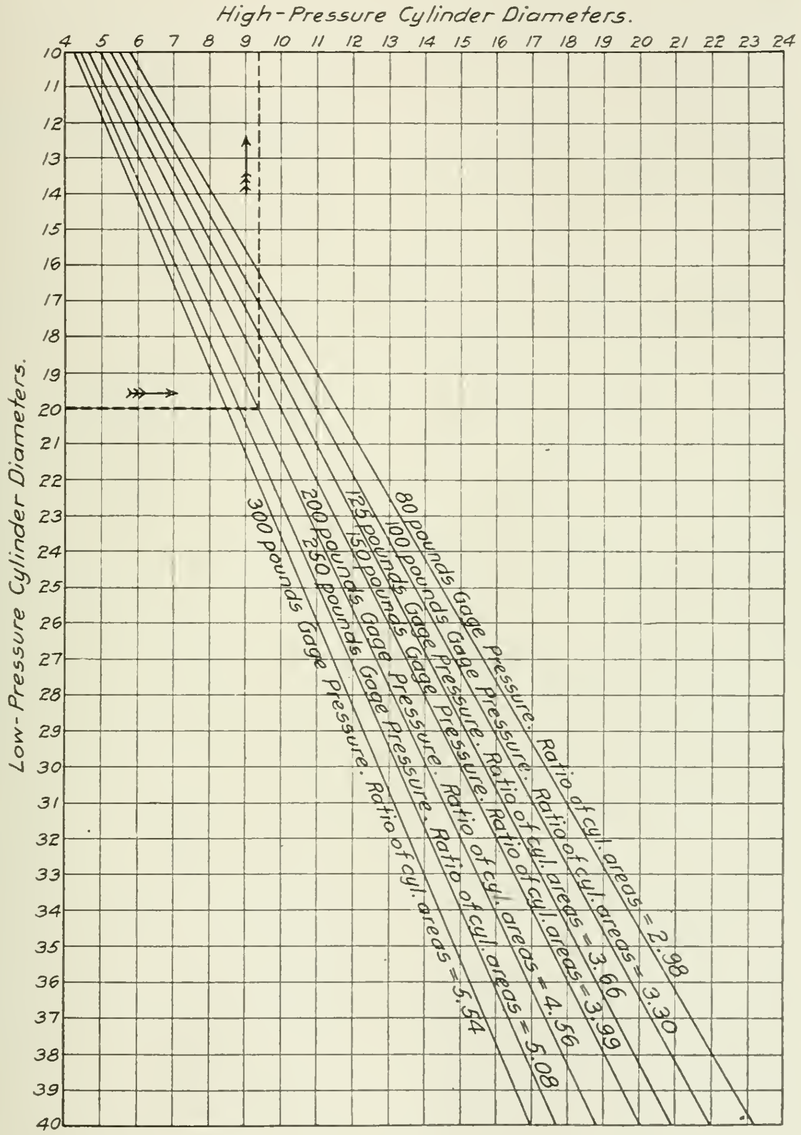
Then came another accident that made the ticket chopper sad. A youth passed the pipe without depositing his ticket. The chopper called to him to put it in the box.

"Don't come back!" yelled the chopper. "Don't come back. Stay where you are." And, forgetting his body also interrupted the stream of air, the chopper left his post to get the ticket. Then he saw the diaphragms meet, and to avoid registering up another fare he had to crawl under the pipe.

"What is that infernal draught?" one passenger asked.

"That's a counter," said the chopper, banging the handle up and down in the glass box and assuming an expression of contempt for a person who seemed ignorant of the compressed air counter's habits. The passenger passed the device, then came back again and looked at it, and was astonished when the man at the box asked him to pay two more fares.

"You've registered three times instead of once, and you've had all the fun out of it," HIGH-PRESSURE CYLINDER DIAMETERS FOR AIR COMPRESSORS—IV.



Compound Air Cylinders for 10,000 feet Altitude Compression.
Atmospheric pressure 10.07 pounds per square inch.

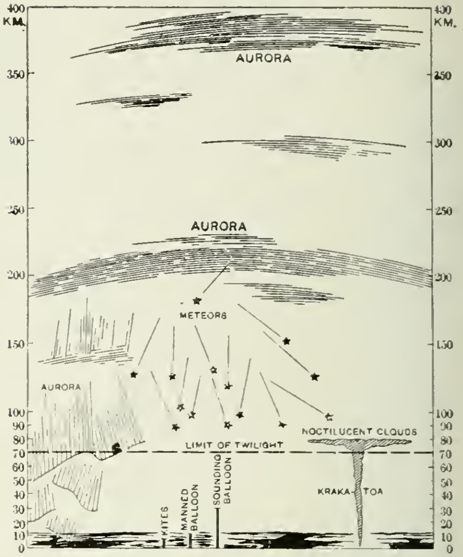
snapped the chopper. The passenger came back again to find out what the tunnel employe was angry about, and finally he was made to understand that every time he passed the device it meant a nickel out of the ticket chopper's pocket, except for the first fare.

"Well," said the curious one, offering the man at the box a half dollar, "how long can I look at it for that?'

"As long as you like, without paying, but don't pass," was the answer. "See that those diaphragms don't touch, for every time they meet that means a nickel that has to be accounted for."

VERTICAL EXTENT OF THE ATMOSPHERE

The accompanying diagram, reproduced from a paper by Dr. Alfred Wegener in a recent number of Das Wetter, illustrates the field of aerological investigation; i. e., the whole extent of the atmosphere in a vertical direction.



THE EXTENT OF THE ATMOSPHERE IN A VERTICAL DIRECTION. HEIGHTS IN KILOMETERS.

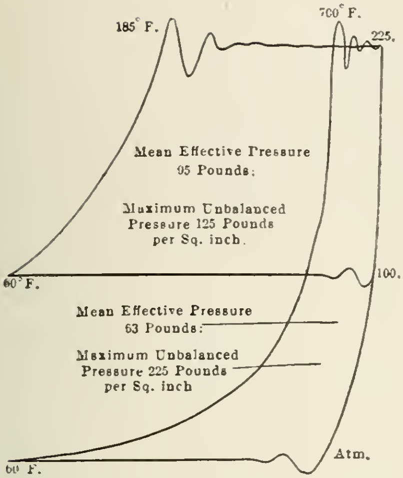
The partly shaded strip at the base of the diagram represents the portion of the atmosphere called the troposphere, or region of convection, extending from the earth's surface up to the level of the cirrus clouds. In middle latitudes its upper limit is at about 10 kilometers (6.21 miles). Within this relatively shallow stratum lies three-fourths of the total mass of the atmosphere, and herein are confined the great convectional disturbances known as cyclones and anticyclones. This region has been explored up to an altitude of 7 kilometers (4.35 miles) with meteorological apparatus attached to kites, and it was penetrated quite to its upper limit by the balloonists Berson and Süring in their ascent of July 31st, 1901, when they attained an altitude of 10,800 meters (35,324 feet).

Above the troposphere lies the stratosphere, or isothermal layer, extending upward to an unknown height. This region is inaccessible to kites and manned balloons, but has been penetrated to an altitude of 29 kilometers (18.02 miles) by sounding balloons, carrying meteorographs. Here the air is exceedingly dry and cold, and is in a state of vertical isothermy; i. e., there is no decrease of temperature with increasing altitude such as we observe in the lower atmosphere. There is probably little interchange of air by convection, and there are no violent disturbances such as constitute the storms of lower levels.

Above the heights reached by sounding balloons we have no direct instrumental record of the conditions of the atmosphere, and must resort to other means of investigation. From the duration of twilight we infer that at an altitude of about 70 kilometers (43.5 miles) the air becomes so tenuous that it can no longer reflect light to the earth. A little higher, viz., at about 80 kilometers (49.7 miles), our topography of the atmosphere must take account of the "noctilucent clouds" observed for some years following the eruption of Krakatoa, and likely to be seen again after any great volcanic eruption. They consisted of dust projected to this great height—far above the highest level of true clouds—by the volcano, and shining with reflected sunlight.

Still higher the presence of an atmosphere is indicated by the trails of meteors, which appear to be especially numerous between 100 and 150 kilometers (62.14 and 93.21 miles) above the earth.

The highest of all atmospheric phenomena of which we have any knowledge are auroral discharges, which, however, also occur at lower levels, down to the earth's surface. These appear to have two levels of maximum frequency, viz., at about 200 kilometers (124.3 miles), and at 60 to 70 kilometers (37.3 to 43.5 miles) above the earth's surface.



A PARADOX OF TWO-STAGE AIR COMPRESSION

The accompanying cut, from the *American Machinist* is used in that publication by Mr. S. B. Redfield in explanation of a rather paradoxical situation which occurs in two stage air compression. In a previous issue of the "Machinist" a correspondent called attention to the use of an air brake pump for compressing air in a single compression to 225 lbs. gage pressure, and then of supplying the pump with air already compressed to 100 lbs. to assist" it, with the result that the pump when thus assisted required considerably more power to drive it than before.

This would mean, Mr. Redfield continues, that if the pump were of the fly-wheel type it would run with less effort if drawing from the atmosphere than if receiving air at an initial pressure of 100 pounds. From this it must not be inferred that it takes more work to fill the second tank with air at 225 pounds pressure when the pump intake is supplied with an initial pressure of 100 pounds, than it would take if drawing from atmosphere; it simply means that the *average* piston effort when drawing from atmosphere would be much less than when drawing from 100 pounds, although the pump would have to work a longer time to fill the second tank when drawing from atmosphere than it would if drawing from the higher initial pressure. The reason for this is that when receiving air at 100 pounds pressure, the air handled in the cylinder is much denser and therefore the mean effective pressure or the work per stroke is much greater, though fewer strokes will have to be taken. The appearance of the indicator diagrams in the two cases is seen in the line cut, and it will be noted how much more nearly rectangular is the diagram when pumping from the high initial pressure than when pumping from atmosphere.

While the *mean* effort would be much less when drawing from atmosphere, it is a fact that the *maximum* effort at the end of the stroke would be almost double, and it is at this point that the pump would stall in the absence of a flywheel, unless assisted by the high-pressure inlet, as actually used. The employment of a flywheel on the pump would carry it over these high peak points at the end of each stroke, and the actual work performed per stroke would be less when drawing from atmosphere.

To get down to figures; the mean effective pressure developed when drawing from an initial pressure of 100 pounds and discharging at 225 pounds, would be about 95 pounds per square inch, while if drawing from atmosphere and discharging at 225 pounds, in a single stage, the mean effective pressure developed would be only 63 pounds. With a 7-inch piston, the mean total piston effort with the high intake pressure would be about 3650 pounds, and with atmospheric intake this mean total load would be only 2425 pounds. At the end of the stroke, however, when drawing from 100 pounds, there would be a maximum unbalanced pressure of only 125 pounds per square inch, or a total maximum load of 4813 pounds, while if pumping from atmosphere, this maximum unbalanced pressure would, of course, be 225 pounds per inch, or total maximum load of 8663 pounds.

While this is a curious state of affairs, it is clear to see that the employment of the auxiliary tank, giving the high inlet pressure, is an advantage, not only making it possible to use a pump without a flywheel, such as is already handy in a railroad shop, but considerable time and total work is saved by this means, in the final filling of the second tank, although this initial work is performed of course, by some other air compressor in the shop.

Aside from the question of work done by the pump, there is the even more important matter of temperature, especially with an unjacketed compressing cylinder With 100 pounds inlet and 225 pounds discharge, the number of compressions is 2.09 and the final air cylinder temperature only about 185 degrees Fahrenheit, while if drawing from atmosphere there will be 16.3 compressions, giving a final air cylinder temperature of over 700 degrees. At such a temperature lubrication becomes a serious problem, as explosive gases often are formed by the action of the located air upon the oil.

used only for supplying air to the working chambers of the tunnel shields under the river. In this way the air capacity could be increased three or four times.

The percussion drills used were of the Ingersoll-Sergeant type, Nos. 3½, A-86, C-24 and F-24.

The air was compressed to 100 pounds per square inch in the power-house and was delivered at about 80 pounds per square inch at the drills. A 3-inch air line was used. The drill steel was 1⅛ to 1⅜-inch octagonal. The holes were about 3¼ inch in diameter at starting and 2⅝ inches at full depth of 10 feet. The powder used on the New York side was 40 per cent. DuPont Forcite, the near presence of heavy buildings and lack of much rock cover necessitating light charges and many holes spaced close together.

		Drilling and Blasting.																Powder Used.		
Type.	Date.	Total feet drilled.			No. of drill shifts. (10 hour.).			Feet drilled per man per hour.			Quantity of excavation, in cubic yards.		Cost of labor only. Drilling and sharpening.				Total quantity.	Cost per cubic yard at 11 cents per pound.		
													Total	Per linear feet.	Per cubic yard.					
	1907	Heading.	Bench.	Total.	Heading.	Bench.	Total.	Heading.	Bench.	Total.	Actual.*	Paid for †	$	$	Actual. $	Paid for. $	Pounds.		Actual. $	Paid for. $
Ke.	May	2 971	5 578	8 549	98	204	302	3.081	2.734	2.881	1 736	1 664	2 331	0.27	1.34	1.40	1 596		0.10	0.10
	June	2 093	6 194	8 287	85	223	308	2.462	2.777	2.691	809	698	2 440	0.29	3.01	3.49	1 960		0.27	0.31
	July	....	7 627	7 627	......	268	268	......	2.845	2.845	1 022	960	2 031	0.26	1.98	2.11	966		0.10	0.11
	Aug	....	2 552	2 552	......	95	95	......	2.688	2.688	743	716	640	0.25	0.86	0.89	430		0.06	0.07
	Sept.	....	2 133	2 133	......	79	79	......	2.700	2.700	238	238	533	0.25	2.24	2.24	280		0.13	0.18
	Total....	5 064	24 084	29 148	183	869	1 052	2.767	2.77	2.77	4 548	4 276	7 975	0.27	1.75	1.87	5 231		0.13	0.13
Ki.	May	6 976	....	6 976	216	....	216	3.229	......	3.229	614	527	1 604	0.23	2.61	3.04	1 230		0.22	0.26
	June	4 069	....	4 069	135	....	135	3.029	......	3.029	357	259	1 234	0.30	3.46	4.76	1 036		0.32	0.44
	July	....	3 733	3 733	......	140	140	......	2.666	2.666	530	404	1 084	0.29	2.04	2.68	550		0.11	0.15
	Aug	....	6 715	6 715	......	249	249	......	2.769	2.769	925	890	1 901	0.28	2.06	2.13	906		0.10	0.11
	Estim. ..	....	14 742	14 742	......	546	546	......	2.700	2.700	3 254	2 908	4 570	0.31	1.40	1.57	2 470		0.08	0.09
	Total....	11 065	25 190	36 255	351	935	1 286	3.152	2.694	2.819	5 680	4 988	10 393	0.29	1.83	2.08	6 191		0.12	0.14
Ko.	May	....	1 617	1 617	......	55	55	......	2.921	2.921	250	188	471	0.29	1.88	2.50	376		0.17	0.22
	June	....	2 948	2 948	......	107	107	......	2.755	2.755	496	347	883	0.29	1.78	2.54	357		0.08	0.11
	July	....	3 734	3 734	......	131	131	......	2.850	2.850	626	606	1 003	0.27	1.60	1.65	609		0.11	0.11
	Aug	....	8 260	8 260	......	290	290	......	2.848	2.848	718	709	2 161	0.26	3.00	3.04	918		0.14	0.14
	Estim....	....	4 787	4 787	......	285	285	......	1.680	1.680	605	535	2 397	0.50	3.96	4.48	762		0.14	0.16
	Total....	....	21 346	21 346	......	866	868	......	2.460	2.460	2 695	2 385	6 915	0.32	2.57	2.90	3 022		0.12	0.14
Grand Total ...		16 129	70 620	86 749	534	2 672	3 206	3.020	2.710	2.710	12 923	11 649	25 283	0.29	1.96	2.17	14 444		0.12	0.14

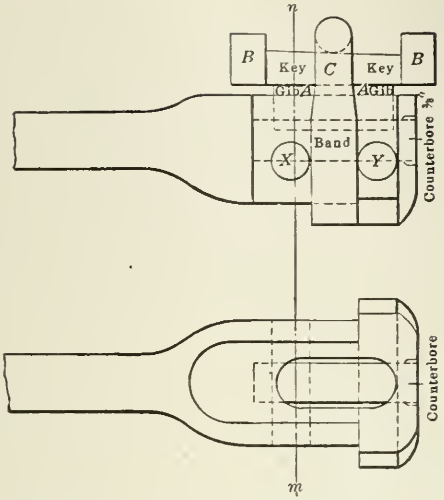
DRILLING AND BLASTING COSTS OF THE PENNSYLVANIA NORTH RIVER TUNNELS

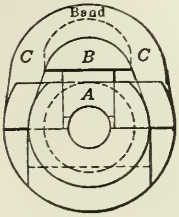
Complete itemized costs of drilling and blasting in the North River tunnels of the Pennsylvania Railroad at New York are given in a paper by Messrs. B. H. M. Hewett and W. L. Brown, describing that work in detail, recently published in the proceedings of the American Society of Civil Engineers, the table above being from that paper.

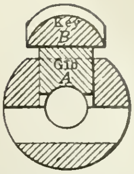
At each plant air was furnished by one high-pressure compressor. This machine had duplex 14¼x36-inch Ingersoll-Rand air cylinders, and was connected to a cross-compound, Corliss-Bass steam engine with 14-inch and 26-inch cylinders. The air cylinder was water jacketed with circulating salt water. This compressor could supply air for about nine drills, running unassisted. But on occasion when there was an unusual demand on account of heavy drilling work, an additional supply was obtained from three low-pressure Ingersoll-Rand machines in each plant, ordinarily

To compensate the contractor for the inevitable excavation done outside the neat lines of the masonry lining, the excavation was paid for to the standard section line, which was 12-inches outside the neat lines on top and sides and 6 inches outside at the bottom of the cross section.

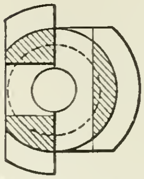
On the Weehawken side, in the rock blasting, 60 per cent. Forcite was used. The average length of hole drilled per cubic yard of excavation was 2.9 feet as against 7.7 feet at Manhattan; and the amount of powder used was 1.96 pound per cubic yard as against 1.24 pounds at Manhattan.



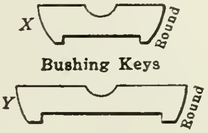




Cross Section on Line *m-n* Gib and Key, but not Bushing Key, shown.



Cross Section on Line *m-n* Gibs and Keys not shown.



Bushing Keys

BOLTLESS CHUCK FOR PISTON DRILLS

In the North Star mines, at Grass Valley, Cal., a special type of chuck designed by Messrs. Paynter and Bastian, employees of the company, is used on the piston-machine drills. The peculiarity of the chuck is that it includes no bolts, and hence does not require the use of a wrench for tightening the hold upon the drill shank. The accompanying working drawing shows the details of the chuck and clamping arrangement.

The chuck is drilled as usual to receive the shank of the drill steel. A slot, above and parallel to the shank of the steel, is cut in the chuck to receive a gib *A* that bears against the shank of the drill. Below the drill socket and perpendicular to the axis of the chuck two holes are cut to receive bushing keys *X* and *Y*, that bear against either end of the lower part of the drill shank and take up wear from the chuck. A strap or band *C* fits around the chuck and over a tapered key *B* that bears on the gib *A*. The key *B* is tapered away from the end of the chuck so that when every impact of the drill against rock drives it further under the strap *C*, the gib is forced more tightly against the drill shank. There is, hence, no tendency of the drill to become loose in the chuck. On the other hand, it is held more securely at each stroke. The key *B* is made with a heavy head at either end.

To fasten the drill in the chuck the key is driven tight by a blow upon the head at the larger end. A blow on the other end of the key serves to loosen it and allows the drill to be removed. This type of chuck has been used for several years in the North Star mines and has proved entirely satisfactory.—*Eng. and Min. Journal.*

SPECIFICATIONS FOR AIR HOSE*

When the question of the purchase of some 50,000 feet of air hose for use at the Mare Island Navy Yard was taken up several years ago, it was found that up to that time no definite specifications were in use under which this hose could be purchased. Applications made to the purchasing departments at other navy yards developed the fact that each yard purchased its hose under special specifications gotten out at that particular plant, and that hose was being used at one place costing 85c. a foot, while hose of a different nature used for exactly similar purposes was apparently answering all requirements at a purchase price of 35c. a foot. It was believed to be a highly opportune time to attempt the preparation of a uniform set of specifications covering all pneumatic hose for use at the various navy yards.

KINKING AND PRESSURE TEST.

After quite a little investigation it was decided to adopt a combination kinking and

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*Condensed from an article in the *American Machinist* by R. D. Gatewood, Assistant Naval Constructor, United States Navy.

pressure test, and for this purpose a special machine was prepared. [An apparatus practically identical was illustrated and described in Compressed Air Magazine, May, 1909, Vol. XIV, page 5279.]

The actual test was conducted as follows: A test piece 20 inches in length was fastened securely at each end by means of a number of elbow-nipple connections, the nipples being slightly corrugated. One inch of the nipple is allowed to enter the end of the hose, which is then secured by two bands of No. 7 B. & S. gage soft copper wire, hove up by a hand vise, so that when the machine is running the give of each sample is as slight as possible, and, as nearly as may be, equal to that of the other samples on the machine. It was found highly essential that all nipples be of the same length and that their ends be carefully rounded off in order to avoid the friction of the end of the nipple on the inner rubber tube. This point was found to be of the greatest importance and in any test of a similar nature too much care cannot be taken to prevent this friction, for it is upon the strength of this inner rubber tube that the ultimate strength of the hose depends. The length of 20 inches was decided upon after considerable experimentation.

The nipple connection above mentioned is made up on a 45-degree elbow, the stationary end being turned up and the moving end turned down. The distance between the ends of the couplings or nipples when level is about seven inches. One end remains stationary and the other end moves up and down through a distance of about 14 inches, by means of a crosshead working in guides, so that the hose is kinked about 80 times a minute. The kinking occurs in two places in the length, about four inches from each end, the angle through which the hose is bent being from 60 to 70 degrees. During the entire time the hose is being kinked, a pressure of 90 pounds per square inch is maintained on the hose, this pressure being the pressure at which the hose is required to work in service. In comparatively few instances in the kinking test was it found that the sample actually burst. The rubber covering of the hose frequently gave way, but this was not considered to be a material defect. The samples were carefully watched, particularly at the end of the specified kinking test, and if a slight leak was discovered the machine was stopped. If there was not found to be a steady flow of air, the machine was again started. If, however, there was a steady flow of air escaping, it was considered as denoting the end of the kinking time for that particular sample.

This specified kinking time was, of couse, the hardest part of the specifications to determine upon, and after tests upon 20 different samples of hose submitted by different companies, the following requirements were decided upon:

Size of Hose.	Length of Test, in Hours.
3-8 inch	45
7-16 inch	40
5-8 inch	30
3-4 inch	25
1 1-4 inch	3

In addition to the above kinking test, all hose was required to stand a hydrostatic pressure of 600 pounds, though under ordinary conditions of service the hose would only be required to stand about 90 pounds.

In addition to the above requirements, the specifications were purposely made sufficiently loose to cover the ordinary commercial grades of hose in the matter of cotton ply. This was done in order not to limit the purchase of suitable hose to hose of special manufacture, such as is now used on vessels of the navy for fire purposes, the idea, of course, being to reduce the cost as much as possible and still obtain a serviceable article.

The kinking test on the large size (1 1-4 inches) was considered to be more or less comparative only. By means of this test on the large size hose, it is possible to pick out *some samples* that are *better* than others, but it is impossible to pick out the *best*. The results of the 600-pound water test were considered of more value as a measure of the quality of the large size hose than were those of the kinking test.

STANDARD SPECIFICATIONS.

From the above test the following specifications were gotten up by the bureau of construction and repair, and are now in use for the purchase of all pneumatic hose used at navy yards under that bureau:

"1. The hose to be made up of an inner rubber tube, three or more canvas or braided layers, and an outer rubber cover; to be of the internal diameter required for.

"2. The tube and cover shall be free from pitting or other irregularities; the tube shall not be less than 1-16 of an inch, and the cover not less than 1-32 of an inch in thickness. The hose to be of the best quality rubber, duck and friction, and to be capable of standing a hydrostatic pressure of 600 pounds.

"3. At the time of submitting bid, and prior to the opening of bids, each bidder shall submit to the general storekeeper at the yard from which the hose is purchased, a sample of each size of the hose on which he is bidding. These samples will be submitted to the mechanical kinking test, and the award of contract will be based on the result, the bidder whose sample shows the best result as compared with the price bid will be given preference, the Government reserving the right to reject any or all bids. No sample shall be considered satisfactory that does not stand the test for the following length of time without leakage at 90 pounds air pressure:

3-8 inch........................	45 hours
7-16 inch........................	40 hours
5-8 inch........................	30 hours
3-4 inch........................	25 hours
1 1-4 inch........................	3 hours

"4. A sample from each delivery will be tested in a similar manner to demonstrate whether it is equal to the sample submitted with the bid.

"5. The kinking test is conducted as follows: The test piece, 20 inches in length, is fastened to couplings made up on 45-degrees elbows, the stationary end turned up and the moving end turned down. The ends of the couplings when level are seven inches apart. The moving end travels vertically through a distance of 14 inches, and the speed is such that the hose is kinked about 80 times a minute, the kinking occurring in two places about four inches from each end. During this test an air pressure of about 90 pounds per square inch is maintained in the hose."

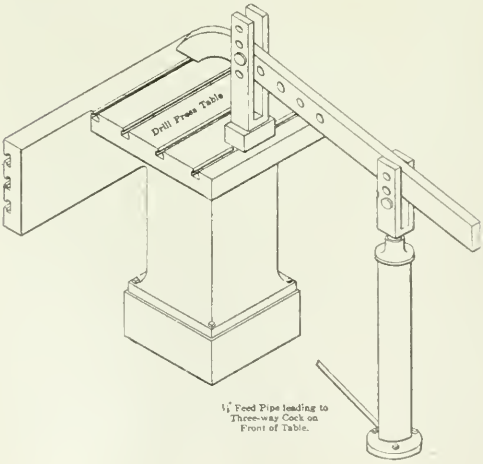
The adoption of the above specifications has resulted in the purchase at a very reasonable price of hose which is amply strong to withstand all service pressures, and at the same time of such construction and pliability as to produce good results in use. The test of comparatively short duration and awards can be made almost immediately after receipt of bids, as the test can be conducted prior to the date on which the bids are to be opened, and it is only necessary to compare the results of the test with the bids in order to recommend award. While it is appreciated that the results do not indicate definitely the manner in which the hose will stand up in service, it is found by experience that hose which stands up well in the kinking test gives good satisfaction in service.

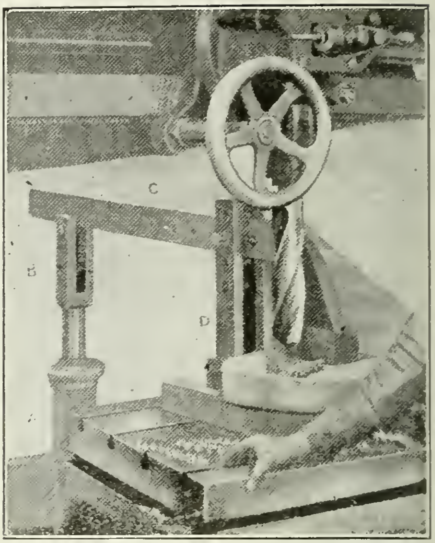
OIL RESOURCES OF CALIFORNIA

Few of us have even begun to realize the wonderful development of the oil industry of California in the past ten years or the enormity of the present and prospective supply. This is strikingly set forth in a recent address by Mr. DeKalb before the California Board at Nevada City, Cal. He calls attention to the very apparent fact that California has entered the age of oil, and that from very modest beginnings it has risen to pre-eminence. Ten years ago it produced 4,000,000 bbls. yearly, now 75,000,000 bbls., and it is estimated that it will keep up its yield for at least 50 years. There are 255 producing wells in the Midway field alone; 10 are veritable geysers of oil. The Lakeview has been spouting 48,000 bbls. daily for three months, outstripping Baku, in Russia, and holding the world's record; 75 square miles of territory has been proved. The oil is found in deposits overlying the ancient eroded surface. Gushers are pools in the deepest scored early land area, as if a canon had been filled with sand and the oil had then been accumulated in the interstices. Gushers may be due to gravity under pressure from a high head, or to expansion of compressed gases accumulated above the oil in a pool. As usual in other fields, the anticlines hold the oil, the synclines the water. The market for oil is constantly widening. A few years ago coal was a competitor of oil on the Pacific coast, today crude petroleum has monopolized the field as a fuel, except for domestic heating.

The facilities for distribution are excellent and will give some idea of the vastness of the enterprises. The Producers Transportation Co. operates an eight-inch pipe line 210 miles to Port San Luis, serving the Sunset, Midway, Kern and Coalinga fields, transmitting 20,000 bbls. daily. The Associated Oil Co., serving the same fields, operates an eight-inch pipe line 350 miles to Port Costa, in San Francisco bay, and a six-inch line 10 miles to Monterey. The Standard Oil, draining from the McKittrick, Kern, Midway and Sunset fields, transmits 35,000 bbls. per day to Point Richmond, 345 miles through an 8-inch main. There are 21 pumping stations in this line. When we consider that the cost of these pipe lines, with all accessories, averaging about $10,000 per mile, one gets some idea of the expense involved, warranted by confidence in the field. A pipe line is even projected to Arizona, to serve the six railroads in that territory, as well as the copper district of Globe, Miami and Douglas, and Canada copper district in the state of Sonora, Mexico.

The consumption of oil on the Southern Pacific system alone amounts to 9,000,000 bbls. per year. California oil goes to British Columbia, Alaska, and the Orient, to Panama and to every Pacific point as far as the Straits of Magellan. There are 6,692 producing wells in the state. As regards investments and cost: It costs $6,000 per acre to drill and equip wells, giving a total investment of at least $100,000,000. Pipe lines alone represent $10,000,000, refineries, tanks, cars, ships, etc., $50,000,000. Land drained by wells, average value, $2,000 per acre, or $60,000,000 total. This gives a grand total of $210,000,000. The output of 79,000,000 bbls. yearly at 40 cents per barrel, is worth $31,600,000; half is available for dividends, hence the oil industry earns 7½ per cent. on invested capital.

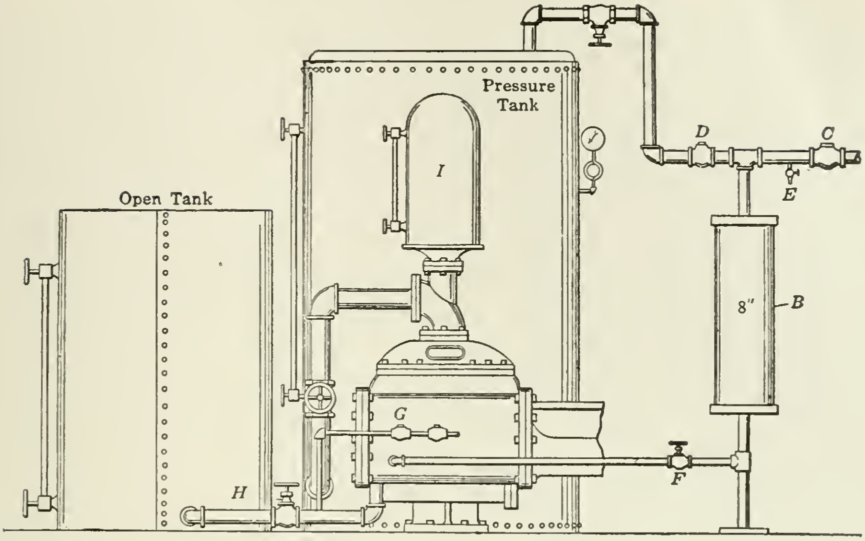




PNEUMAUIC CLAMP OR WORK HOLDER

The half tone and the isometric sketch on this page, reproduced from the *American Machinist*, show a handy pneumatic clamp which is provided for every machine having need of it in the Beech Grove shops of the Big Four Railroad. Practically no explanation is required. The most frequent use of the clamp is upon the radial drill, as seen in Fig. 1. It consists primarily of the pneumatic cylinder *A*, which has a pipe from the air line running into its base. When air is admitted it forces the plunger *B* up against the clamping lever *C*. This clamping lever fulcrums in the yoke *D*, which is made to be easily fastened to any part of the table by T-headed bolts so that it can be applied in almost any position. Any shop having an air supply, and what railroad shop has not? will find the clamp a great time saver, as it entirely does away with the use of straps and bolts in any work of its kind, doing both the clamping and the releasing instantly.

"Aggie is fifty, and so thin that when she wears a tailor-made suit she has to build out with pneumatics. You remember, at the Woman's Suffrage Convention, how Mrs. Bailey pinned a badge to Aggie, and how there was a slow hissing immediately, and Aggie caved in before our very eyes."—*Saturday Evening Post.*



Piping by Which Pump Is Made to Supply Air to System

PUMPING AIR WITH A WATER PUMP

The accompanying sketch shows an ingenious method of forcing air into the pressure tank of an hydraulic-elevator system. The cost of installing this device is small as compared with that of an air compressor, and it gives very satisfactory results.

The method of operation is as follows: First, valve *F* is opened while the pump is in operation and when *B* becomes full petcock *E* will show water. Just before air begins to be sucked in, on the return stroke of the pump, *E* is closed; this draws air in through check valve *C*. On the next stroke of the pump, the pressure closes *C* and forces valve *D* open, and the air passes over into the pressure tank. By this arrangement, no air gets into the body of the pump, the reservoir *B* being filled with water and pipe *F* is not sufficient to drain it at one stroke of the pump.

The pipe and check valve at *G* is for charging the air chamber *I* which loses air through the gage valves. By closing valve *H*, air is drawn in through *G* and soon appears in the top of the glass on the air chamber.—*Power and the Engineer.*

Cincinnati factories are now using 300,000,000 cubic feet of natural gas per month. The Government building is the latest large consumer.

THE COMPRESSED AIR SERVICE ON THE PANAMA CANAL

The following is a recent summary by *The Engineer*, London, of the compressed air installations on the Panama Canal work. It is premised that all the drills are operated by compressed air. The system supplying air to the drills in the Central Division and at the Pedro Miquel and Miraflores locks, for the large shops at Empire, and the field repair shops at various points, extends a distance of about 13 miles. The main line is made up of 38,800 ft. of 10-in., 14,600 ft. of 8-in., 10,000 ft. of 7-in., and 4,000 ft. of 6-in pipe, and from these mains air is conveyed to different parts of the cutting by "leads" aggregating over 34 miles, composed of 2-in. to 8-in. pipe. There are three compressor plants, situated at Rio Grande, Empire, and Las Cascades, each equipped with two Ingersoll-Rand and two Laidlaw-Dunn-Gordon compressors, with an aggregate maximum output of 1,800,000 cubic feet of free air per hour. Since the installation of oil-burning apparatus the fixed daily charges in connection with these plants, now being added to by the installation of Rand compressors at Rio Grande and Empire, have been reduced by over £25. Other extensive air-compressing plants are running at Balboa, Porto Bello, and at the Gorgona and Cristobal shops.

RAIN AT PANAMA

The rainiest July of record on the Isthmus was that which has just closed. There were showers on each of the 31 days, and some of the most violent of these occurred during hours when work was in progress on every section of the Canal and railroad. A popular deduction from past rainy seasons is that there is likely to be a heavy shower between 12 and 2 o'clock each day, and the meteorological records on the Isthmus sustain this belief, to the extent of showing that the noontime rains are very frequent and often heavy, as much as two inches of rain falling in one hour.

At Gatun during the hardest part of such a storm, one who looks out across the valley from the division office can see but dimly the lock monoliths and the cableway towers nearby, while the workers on the Dam beyond the locks are quite obscured from view. Gradually the more intense rain gives place to a gentler downfall, and it often happens that within half an hour after the blinding shower the sky is blue and the sun is shining. To one who watches from shelter it is a fair assumption that during the most violent part of the rain the men have found some protection and the work has been temporarily suspended. He can see that this is not true during the drenching but gentler parts of the storm; and if he were out on the Dam, at the spillway, or in the lock site, he would know that the work seldom ceases during any part of the rain.

The men at work on the toes of the Dam cannot shift track so rapidly in wet as in dry weather, and there is an added inconvenience in the dumping of rock and earth from the spoil trains but they can do some work and, while they can, they do it. In a locality like Gatun, where rain is the rule and fair weather the exception, this persistence through the heaviest showers makes a great difference in the amount of spoil that can be unloaded on the toes of the Dam, and it explains in a measure why that work is keeping pace with that on the Locks. Showers make no difference to the force on the hydraulic fill, because the dredges and relay pumps are under cover, and at the spillway it is not allowed to interfere; the men put on their waterproof coats and keep at work.

Half of the concrete work at the Locks is also done under cover; that is, the materials are sent to the mixers, mixed, and delivered over the lock site by men protected from the rain. They set the pace for the outside workers. Concrete is spaded into place as long as the cableway operator can see the signals of the man whose flag directs the movement of the buckets, and all the rest of the work moves in consonance with this.

One of the wettest places in Culebra Cut is the pit in which a steam shovel works, because the pit is filled knee-deep with water, and there is no protection overhead. The pitmen are laborers, usually negroes, and they pay as little attention to the rains as the Spanish track laborers, and the white Americans who direct the work. A statuesque picture of indifference to weather is the conductor of a spoil train running out of Culebra Cut. The engineer and firemen are in the locomotive cab and dry, but the conductor is entirely exposed during the heaviest storms, as he sits on the high side of the rear flat car of a train carrying spoil to the dumps or running back to the Cut where some steam shovel is waiting for more cars. It is an unusual storm that forces a steam shovel to suspend, unless the drainage of the pit is stopped and the water puts out the fire. The track gangs keep at work in the Cut and on the dumps where the mud is literally up to their knees, because disposing of the spoil, not excavating it, is still the determining factor in the digging of Culebra Cut.—*The Canal Record.*

FIREDAMP AND BAROMETRIC PRESSURES

An elaborate memoir on this subject has recently been prepared by M. Léon Morin, of Liévin ("L'Influence des Variations de la Pression Atmosphérique sur les Dégagements de Grisou," *Bulletin* de la Société de l'Industrie Minérale, July, 1910). At the outset he gives a synopsis of the views published in this country and elsewhere, and finds that most engineers of experience are in agreement as to the influence of atmospheric pressure on the emanations of firedamp from old workings, but that opinions differ as to the influence of these variations on emanations at the working face. For some time observations have been made at Liévin, and these establish the two main facts that heavy depressions of the barometer are followed by the appearance of traces of firedamp in certain feeblyventilated roadways or in roads terminating in a *cul-de-sac;* and a rise in the proportion of firedamp in several return airways. M. Morin arrives at the following conclusions:—

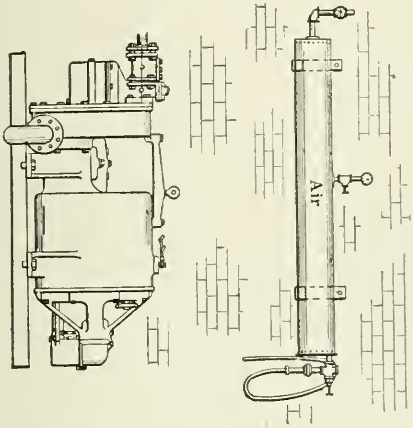
1. That variations of atmospheric pressure, even when very slight, produce variations in the emanation of firedamp; all things being equal, when the pressure is constant, emanation of firedamp is equally constant.

2. When the atmospheric pressure increases, the emanation decreases, and, inversely, if the pressure decreases, the emanation increases.

3. A maximum of atmospheric pressure correponds with a minimum of firedamp content, and *vice versâ.*

4. The variations can be very considerable, a fall in the pressure from 770 mm. to 740 mm. giving a variation in content of 50 per cent.

5. There is no strict relationship between the variation in firedamp content and the variation of pressure.



A COMPRESSED AIR DUST BLOWING OUTFIT

The accompanying illustration shows the method used by an engineer in Richmond, Va., for obtaining an air supply for blowing out dust from the generator end of a small Curtis turbine set.

In his plant was a small belt-driven air compressor, which furnished compressed air for removing shavings from the wood-working machinery in the factory to the boiler furnaces. In this case a small 30-gallon water tank was obtained which was capable of withstanding an air pressure of 70 pounds to the square inch. This air tank was secured to the wall of the engine room directly over the turbine unit, by means of two hangers made of ⅛-inch strap iron, curved so as to form a cradle for the tank, as shown. At one end of the tank was fitted a nipple to which was screwed the air pipe running to the compressor, this pipe being fitted with a valve to permit shutting off the tank from the air-pump line. On the other end of the tank, at the top, was fitted a long nipple to which an angle valve was screwed. To this valve was screwed another long nipple to which a hose coupling was attached, the hose being long enough to reach to all parts of the turbine as well as to the switchboard. The tank was inexpensive, neat in appearance, being painted with aluminum, and efficient in operation.—*Power and the Engineer.*

TUNNEL PRESSURE EXPERIENCES

In the account by Mr. C. H Hollingsworth, superintendent for the contractors, the Buffalo Dredging Company, in the construction of the Buffalo Waterworks Tunnel, the following has to do with the experiences of the men working under air pressure. But few accidents or serious injuries occurred in the three and one-half years of working. One man was killed by an elevator and another had a leg crushed by an electric locomotive. The chief and constant trouble was from bends or caisson disease.

This was usually confined to new men, however, and Mr. Hollingsworth says, I should judge that from 75 to 90 per cent. of the new men had it in a greater or less degree either in their first or second shift on the work, in spite of the fact that any new men on a shift were brought out of the air by their foreman or the lock tender after the other men were all out, so that they could take plenty of time. The time of decompression lasted from 12 to 15 minutes in 25 lbs. of air. On the other hand after they had gotten over their first attack it seemed next to impossible for them to get the bends again, no matter how quickly they came out, with a few exceptions. As for the exceptions noted, it seemed impossible for them to come out at any speed whatever. Some of them after coming out from work would be attacked with the bends while in the dry house and would immediately be placed in the hospital lock and the pressure run up about ½ lb. higher than the pressure under which they had been working and the outlet valve set from the outside so that the decompression would be at the rate of about 5 minutes per pound, or about 2 hours for 25 lbs., but on coming out they would often be attacked again. The next time the time would be increased to 2½ hours and even then it would often prove useless, and we have had men that failed to get rid of it after going in the lock three or four times with hot baths and hot coffee between times. They would then be sent to the hospital and with these stubborn cases the men were not allowed to go back to work. The other workmen in spite of orders would go in and out of 25 lbs. of air from 1 to 2 minutes and feel no effects. One thing noted was that either in summer or winter a damp spell would bring on several cases of the bends. Also men that were subject to attacks of rheumatism would have a touch of the bends immediately after such an attack.

A peculiar thing was that while the atmosphere away from the locks was quite cold and that near the locks was intensely hot, the lock tenders had as much or as little of the bends as the others. The air from the compressors was discharged near the locks and there was sufficient leakage at the heading to cause considerable current and to make the air quite cool. Otherwise, the supply pipes would have been carried close to the heading.

A SOAP BUBBLE CELEBRATION

The following letter to the *Scientific American*, purporting to be from a small boy in California, makes reading of interest to various ages:

In our town of Berkeley we have a new government which will not let little boys have any fireworks on the Fourth of July. My father thought that was a good idea, but he wanted me to have a good time on the Fourth of July just the same, so he got up this experiment for me and my friends instead of fireworks.

He took about a quarter of a pint of Italian olive oil and boiled it about two hours with about four ounces of common caustic potash, such as is used for wool washing, he dissolved the potash in about half a pint of water before boiling it with the oil. After the mixture had been boiled two hours the soap was ready, and he strained the extra water and potash off after the mixture had gotten stone cold and stood over night.

The next morning, which was Fourth of July, he got the biggest dish-pan in the house, about two and one-half feet across, and he made up a solution of the soap in about four gallons of water, then he took the garden hose and fastened it to one of the larger gas pipes in the cellar and put the other end in the bowl of soap water, and then turned on the gas. The dish-pan quickly filled up with a mass of bubbles all fastened together, each bubble being about as big as my fist, and then because they were so light on account of being filled with gas they began to try to rise up, but they were so stuck to the soap water that they did not break away till there was a mass of them nearly as big as the largest sized watermelon, then they sailed away and we watched them till they were out of sight. As soon as one bunch of bubbles had sailed off another bunch began to form, and sometimes we could see as many as twenty in the air at once. Some of them we could watch as long as three and a half minutes by the watch before they went clear out of sight. We kept up the game several hours, and the amount of gas used up was 32 cents worth, which was a cheap enough Fourth of July.

A dust collecting machine for card rooms is being introduced into English factories. It is self-contained and does not require the erection of any overhead piping. It consists of a dust-collecting receptacle mounted on a trolley which can be wheeled down the alley between the cards and employed to remove the dust from each card as it is stripped. Within the dust-collecting receptacle a fan of special type is mounted. This fan is driven by a rope from the rope pulley of each card. Suitable flexible pipes are connected to the dust receptacle and can be connected to a cowl or cover surrounding the stripping brush. The inner side of the receptacle is covered with cloth, which acts as a filter, and, although allowing the induced air to escape in the atmosphere of the card-room, prevents any dust or other foreign matter from passing through. When in position the flexible pipe is connected to the cowl, or cover, and stripping commences. The dust generated by the stripping process is collected in the receptacle, the strips in the brush being removed by hand as hitherto.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
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W. C. LAROS, - - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. OCTOBER, 1910. No. 10

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CHARLES TALBOT PORTER

Charles Talbot Porter died at Montclair, N. J., on August 28. He was a distinguished engineer and the most recent recipient of the John Fritz medal established as a recognition of notable scientific or industrial achievement. The four men receiving this medal prior to Mr. Porter were Lord Kelvin, George Westinghouse, Alexander Graham Bell and Thomas A. Edison.

The John Fritz medal of distinction was conferred upon Mr. Porter by the four national engineering societies because of his work in perfecting the high speed steam engine. Prof. Hutton, of Columbia University, at the time this medal was conferred upon Mr. Porter, said that "the reciprocating engine owed to him the first vision of the advantages that come from making the crank shaft turn at a high number of revolutions, whereby the weight of motor per horse power is reduced. From this thought sprang the modern design of the motor for self-propelled vehicles and for the aeroplane."

Mr. Porter was born in 1829. He was the mechanical head and dictator of the Porter-Allen Engine Co. In 1867, he installed the only high speed engines exhibited at the French Exposition. He forced new ideas of speed possibilities upon the engineers of the world.

To so design an engine that the weight of motor per horse power is reduced, and at the same time to secure economy and durability, is an advance of no little importance in engine practice. As we look over the encyclopedias of mechanics and see the pictures of primitive engines, whether they be steam engines, pumps or air compressors, the first thing that impresses us is that the older the design, the heavier, more complex and slower of speed it appears to be. The old Cornish pump and the original Watt engine were slow moving, cumbersome, heavy devices. The horse power per unit of weight was small, and if efficiency means something more than low coal consumption, if it means also less material, less space occupied, requiring less attention on the part of the engineer, then the modern steam engine compared with the old is a highly efficient machine.

What has been done with the steam engine is now being done with the air compressor, which is, after all, only a steam engine applied to the compressing of air. It was originally supposed that the efficiency of an air compressor was in direct proportion as its speed was reduced. Manufacturers called attention to the slow speed as an argument in favor of the permanency and efficiency of the machine. This was all very well during the time that steam engine practice depended upon low speeds; it was all very well when pneumatic engineers had not learned how to compress the air in stages and to cool it before, during and after compression; it was all very well before splash lubrication and the automobile system of boxed-in crank shafts and automatic oiling had been established. To-day there is no more reason why the air compressor should not be run at high speed than that a steam engine should be put back in the place it held twenty-five or more years ago. A *common* air compressor will not stand high speeds, and will not give high economy when so driven. The same may be said of a common steam engine; but an air compressor designed for speed, with large ports and passages, large bearings, approved systems of cooling, and with splash or flood lubrication, should weigh less, and it actually does produce a cubic foot of compressed air at a higher general efficiency than the old fashioned, slow speed machine.

ELECTRIC AIR A PNEUMATIC INVENTION

There is at least one curious thing about the development of the electric air channeler, and, in fact of the electric air drill also, in that while the invention as completed and applied is quite revolutionary in its character, and has made the employment of electricity for all kinds of rock cutting not only possible but highly economical and desirable, there is in the device no improvement of or addition to existing electric apparatus, and we might say, no electric invention is involved. In this case electricity has not made work for itself as in so many fields it has done, but work has been made for electricity. In both the electric air drill and the electric air channeler an ordinary electric motor is used, with the ordinarily available current, but new results are accomplished by it, and the electric air percussion rock cutter is one of the most successful of mechanical novelties in recent years.

The electric motor is used in this case with thankfulness for the existence and availability of it, but with no thanks to electric invention for developing its so successful application in this field. This is not the first instance, nor perhaps the largest field, in which pneumatic apparatus has provided employment for electricity as the ultimate motive force. The electric air drill with the electric air channeler now make it possible to employ the electric current as the sole means of power transmission for mine or quarry, and to dispense entirely with large compressor plants and long pipe lines in many cases.

It is rare indeed that new inventions develop great advantages and economies without entailing also some partially off-setting objectionable features, and the absence of the latter in the case of the electric air drill has been widely commented on. In fact no sacrifice or even compromise of any desirable working feature has followed, while the saving in power alone is indisputably demonstrated to range up to 60 and 70 per cent. at the power house.

The same characteristics of convenience and economy are emphasized and extended in the application of the electric air principle to the rock channeler. The machine as a whole is much simplified as compared with the steam channeler, or even the air actuated channeler of the older types. Instead of the motor and pulsator separate from the percussion mechanism, and requiring to be separately handled with every change of location, these do not require to be moved or looked after at all, being securely and permanently fastened upon the base of the machine and by their weight contributing to its balance and stability. Instead of the two pulsator cylinders with the two cranks to operate them for the electric air drill, there is but one pulsator cylinder and a single crank on the channeler. The one motor serves not only to operate the channeling steels but also to feed the machine along the track in either direction and the wires, which are the only power connection, permit a longer working travel than is ever required in practice.

The flexible hose, connecting, at each end of each, the pulsator with the channeling cylinder, in no way interfere with or limit the possible angular adjustments, so that the channeler is used not only for cuts vertical or nearly so but also for undercutting at angles approaching the horizontal. The perfect and constant lubrication of the machine was never so well provided for. The same air being used over and over, the oil is not carried away by the exhaust, as there is none, but remains in the machine, and in fact may be considered a part of it to perform its function the same as the piston, the connecting rod or any other essential mechanical member.

The saving of power by the employment of the electric air principle in drill or channeler is so acknowledged and so familiar as to require no further mention or explanation. Perhaps the habit of time saving which also may be claimed for the devices should be more insisted upon. There is no fixed speed for the ordinary air or steam operated rock drill. It works slower and faster, and when the bit sticks there is nothing doing until the operator does something to free it. The electric air drill or channeler goes along with the rhythm of a military march. The motor and pulsator run at uniform and contant speed, and for every stroke of the pulsator there is also a stroke of the steel upon the rock. If the steel sticks, so that it does not withdraw promptly and completely from the cut, the pulsator keeps up its steady and alternating pull and thrust, and before the stoppage is realized the steel is striking steadily again. The electric air drives an express with few and short stops.

ROCK TUNNEL METHODS AND RECORDS

[The following letter, which appeared in *Engineering Record*, August 20, is entirely self-explanatory. As will be seen it follows a letter in the same columns having to do with the excellent record made at the tunnels of the Buffalo waterworks:]

Sir: Let me discuss as briefly as possible Mr. C. H. Hollingsworth's very intelligent and practical letter on rock tunnel records published in the *Engineering Record* of June 18. I share with Mr. Hollingsworth the desire to see some figures of cost in the Loetschberg tunnel records. These have not been far so available, and the main point to which I have endeavored to call attention is that by the system employed in these Alpine tunnels they have doubled the former rates of progress. There are many reasons why speed is of the greatest importance in tunnel driving. This is especially true in the case of long tunnels. At the Simplon, for instance, a large bonus was offered provided the tunnel was completed in a certain time. This bonus was so large as to warrant a considerable sacrifice of running costs to progress. The unit of cost, or the cost per cubic yard to contractor, may be greater, but the cost of the finished tunnel may be less to the railroad company, because of the shorter time required for its completion.

The contract price for the Simplon tunnel was about $12,500,000. To this should be added the preliminary construction work, or $1,500,000. Half the cost, plus the preliminary work, would approximate the average amount of money involved during construction, or $7,750,000, which at 4 per cent. would be $310,000 per annum or about $1,000 a day. This figure is equal to about $2 per cubic yard, assuming an output of about 500 cu. yd. a day, and it shows the importance of speed in a long, expensive tunnel.

The question of top or bottom heading is one which depends so much upon the nature of the rock and other conditions that no general rule can be adopted. The justification for driving a bottom heading, at an increased cost over a top heading, is the gain in speed and the facility and economy in handling soil for the full section.

The data in Mr. Hollingsworth's letter of performance in top headings of the Buffalo waterwork tunnels provides a basis of comparison with the work in the bottom headings in the Loetschberg tunnel. The following tabu-

	Buffalo.	Loetschberg.
Mucking out headings........	1 hr. 35 min.	3 hr.
Setting up columns or carriage, starting drills..............	45 min.	40 min.
Drilling time................	4 hr. 30 min.	2 hr.
Removing drill carriage or columns and loading and firing holes	50 min.	1 hr. 40 min.
Clearing out smoke...........	20 min.	40 min.
	8 hrs.	8 hrs.

Size of heading in feet........	8 x 15	6½ x 10
Area in square feet...........	120	65
Number of rounds fired.......	1	2
Average area of face per hole drilled, sq. ft...............	6⅔	5 5/7
Number holes per round......	18	12
Depth of holes in feet........	7 to 7½	4
Size of hole at bottom, in.....	1⅝?	2
Total feet drilled per shift....	126-135	96
Feet drilled per drill hour....	7.33	12
Powder. 60 per cent, per cu. yd., lb.	3	7?
Number of drills (Ingersoll-Rand)	4	4
Size of drill, diam. of piston, in.	3¼ (E-24)	3⅝ (P-94)
Effective air pressure at drills, lb.	95	95
Average pull per foot of drilled hole when blasted..........	.71	.87
Gain in pull over Buffalo, per cent	..	22.5%

lation of the different operations during an eight-hour shift at each tunnel heading shows the proportion of time and other detail.

The tabulated comparison of the Buffalo and Loetschberg tunnels shows that the heading area at Buffalo approximates twice the size of the heading at Loetschberg, that in proportion to area Buffalo has but one-third of the drill capacity. Owing to the closer spacing of holes, the larger diameter of the hole at bottom, and the very much greater quantity of dynamite used in the Loetschberg tunnel, a greater advance (22.5 per cent.) is made per foot of hole drilled.

At Buffalo, drill columns are used; at Loetschberg, a special carriage with an I-beam arranged to carry a drill bar, upon which four drills are mounted, in advance of the carriage. The intention in this arrangement was to expedite the placing and starting of the drills after blasting.

The chief point brought out by these figures seems to be that the drilling time is so much slower in Buffalo than in Loetschberg, and this is mainly due to the smaller drills at Buffalo. Had the larger drills been used (3⅝ in., same as at Loetschberg) an equally favorable showing in all respects might have been made, but here the point comes in, that in order to use a large drill properly one must have some sort of carriage, and at Loetschberg they have a very simple form of carriage, which gives them the benefit of the large drill.

A comparison of the Loetschberg with the Pennsylvania Railroad tunnel at Bergen Hill shows that in the Pennsylvania tunnel the drills were hitting the rock 25 per cent. of the total time, while at Loetschberg the evidence is given that the drills were hitting the rock 50 per cent. of the time. In the Buffalo and Loetschberg figures given here the words "drilling time" must not be taken as "hitting the rock," as drilling time includes time lost changing steels, stoppage because of bad holes, change from one place to another, etc., while hitting the rock means just what the words imply; that is, it is the time taken doing the actual work of drilling. Here we have an important point to work upon. We must, in the first place, use a large drill in order to make rapid progress, in order to use high pressure without inordinate breakage of parts. Having these large drills we should so mount them that they will be hitting the rock as much of the time as possible.

Mr. Hollingsworth criticises the statement that with a greater number of holes and greater blasts access can be made to the heading sooner than under the present system. The words "heavier blasts" do not give the meaning that I intended to convey. What is meant is that a large number of shallow holes (these holes being of large diameter at the bottom) will break up the stone to better advantage than a small number of deep holes, small at the bottom. The material will break better, will be thrown farther from the face, and will be quite sufficiently mixed up in size to facilitate loading. W. L. Saunders.

FOR CENTRAL COMPRESSOR PLANTS

"The story is told, and is vouched for as being true, of a requisition that was received from a small shop on a western railway for an additional air compressor. The necessity for this could not be understood at headquarters, and the superintendent of motive power sent a member of his staff to investigate. The shop was in a district subject to extremely high temperatures, and it was found that the master mechanic, in order to rest comfortably, had installed three or four nozzles in the bedroom of his bungalow connected to the compressed air system. The turning of a valve when he retired to his room would insure a cool and comfortable night's rest. It is needless to say the air compressor was not furnished."

The above we copy from the *Railway Age Gazette*. The incident narrated speaks for itself and requires no comment. The editor however, follows it with a line of remark with which we cannot entirely agree. He says:

"This is hardly more extravagant than the practice at a number of terminals or important points of furnishing compressed air from one power plant for the repair shops, car repair yards, roundhouses and classification yards. This not only requires a large amount of extra piping, but the air pressure at the outlying points varies greatly and is not at all satisfactory. It is far better to install two or three electrically driven compressors at the more important centers of distribution. Electrical energy may be transmitted to these points from the central power plant far more efficiently than compressed air. The reduction in the length of piping reduces the cost of maintenance, especially in cold weather when the moisture gathers and freezes in the pipe and has to be thawed out."

It is becoming the established practice, and many considerations favor it, to install in cases like this a central compressing plant for the entire system, using units as large as the circumstances will warrant, with sufficient duplication to guarantee the maintenance of service except in extraordinary contingencies. Compressed air is thus furnished more cheaply as regards both power and labor, and the air service is better in every way. If after-coolers are used, followed by water separators, freezing up is practically eliminated. The piping should be of adequate capacity so that, say in a large railroad shop, there should be nowhere a drop of more than 5 pounds from an initial pressure of 90 or 100 pounds gage.

The large contracting engineers, as upon the New York Barge Canal or the Catskill Aqueduct, in each case depend upon a central compressing plant although the distances are several times greater than those of railroad yards. Those most familiar with properly installed and managed compressed air plants have little to say about leakage as they encounter so little of it.

AIR CURRENTS ROB MINES OF MOISTURE

The following interesting matter bearing upon the necessity of counteracting the drying effect of air currents in mines is from a paper by Erskine Ramsay before a gathering of Alabama engineers and officials:

The amount of water an air current will take out of a mine in cold weather is surprising and startling. At Banner the ventilating current amounts to 200,000 cubic feet per minute, and for the purpose of calculation the inlet and outlet will be considered of equal volume. From the tables it is found that this volume of air when saturated and at a temperature of 40 deg. F. will carry into the mine in 24 hours about 14,000 gallons of water in the shape of moisture. The same current, heated to the temperature of the mine, say 65 deg. F., will carry out of the mine about 34,000 gallons, thus robbing the mine of 20,000 gallons each 24 hours. Unless the mine is to be dried out and become dusty, this moisture must be supplied to the air current from steam jets, pools of water, hose, sprays or other means. At Banner it is sought to supply by sprays at least a part of this loss. The 31 sprays now installed will deliver about 30 gallons per hour and with all of them working, a total of over 22,000 gallons would be delivered during each 24 hours or a little more than is taken out by the current.

THE PROBLEM OF AUTOMATIC STABILITY OF AEROPLANE

It is claimed that the problem of the automatic stability of aeroplanes has been solved by Lieutenant J. W. Dunne, of Farnborough, England. At the trials the machine rose to a height of about 60 feet and then flew for a distance of about two miles without the touching of a lever or wheel, the machine during the whole time being in absolute equilibrium. The machine is a biplane, the most remarkable feature being the absence of a tail and steering surfaces or rudders of any kind, with a single exception of a couple of small steering flaps hinged to the rear extremities of the upper surface for the purpose of altering the course of the machine during the flights. The carrying planes are provided with a double curvature which, it is claimed, produces the automatic stability.

PRODUCER GAS FOR SMOKE ABATEMENT

The Sub-committee of the Glasgow City Council on Air Purification report that during June and July the smoke inspectors had made 245 inspections of boiler and other furnaces, and 2270 observations of chimneys, as a result of which 24 intimations of excess smoke had been made. Gas engines and producers are steadily being substituted for steam boilers. One firm has discarded its boilers and installed instead two engines of 50 and 60 indicated horse-power, working off one suction gas producer; another has taken out its steam engine and put in three suction gas engines, with accompanying producer plant, retaining its steam boiler for heating purposes only during the winter season. A third has installed a 60 indicated horse-power suction gas engine with producer plant, being the second engine introduced within the last eighteen months; in consequence of which three Lancashire boilers have been discarded and two chimneys rendered inactive. The Electricity Committee have decided to construct a model dwelling for the purpose of showing the use of electricity for lighting, heating, and cooking, to be exhibited at the Smoke Abatement Exhibition.

NOTES

The annual per capita consumption of coal in the United States constantly increases. In 1880 it was 1.4 tons per capita; in 1892, 2.3 tons; and in 1907 it was 5.4 tons.

Experiments and observations on the decay of stone antiques in England have developed the discovery that the decay of stone work usually laid to the weather is really the work of bacilli which thrive on the chemical substances distributed in the air by soot and smoke.

A Chester, Pa., a man was killed by the blowing off of the bead ring of a detachable rim tire of an automobile wheel. The owner was pumping air into the tire and the man was seated on an embankment watching the operation when the ring flew off striking him in the face and cutting into his head so that he died in ten minutes.

The Southern Pacific Railroad has had the Baldwin Locomotive Works build for it some what would be called backward running engines, to burn oil from the California fields. The engineer and fireman are in front, like the motorman of a street car. This is possible because the tender, carrying the oil supply, does not have to be so close at hand.

Compressed air for cleaning the electric machinery in all parts of the filtration building of the Cincinnati water purification works has been made available, by the installation of a motor-driven compressor and a small air receiver in the pump room of the head-house. From the receiver a 1-in. pipe line, with suitable outlets, is run through the pipe gallery of the filter-house and into the chemical house. A flexible hose attached to outlets on the line permits the electric equipment to be cleaned readily.

The waterworks of Vienna which have been under construction for about 10 years, are now nearly completed. Supplies are derived from mountain springs and brought to the city by an aqueduct, 113 miles long, built mainly of concrete and measuring 6 ft. 10½ in. high by 6 ft. 3 in. wide. Numerous tunnels have been driven on the line of the conduit, one of them at Göstling being 3 1-3 miles long, while the total length of the tunnels aggregates nearly 53½ miles. As a general rule, valleys have been crossed by siphons with a collective length of 13 miles, but there are also about 100 bridges accounting for some 5 miles of the aqueduct.

No substance that refuses to dissolve in water has an ordor. It is the actual substance itself, floating in particles in the air, that appeals to the nose, and not simply a vibration of the air, as in the case of light and sound. The damper a thing is the more powerful the odor it gives off. A pleasant proof of the fact can be had by walking in a garden after rain. There is no end to the curiosities of smell. It is, for instance, the vapor of a liquid that smells, and not the liquid in the mass itself. If eau de cologne be poured into the nostril the nose refuses to recognize any odor there at all.

An unnamed "authority," quoted by an exchange, gives the following rather indefinite statement of losses incurred in electric generation and transmission: Loss due to friction of steam-engine, 10 per cent.; loss in belting between engine and generator, 3 per cent. If direct-connected this is not figured. Loss in generator, 10 per cent.; loss in line, 10 to 20 per cent.; depending on its length, size of conductor, care in building line, etc.; loss in motors, 12 to 20 per cent. depending on kind used and service required by them; 5 to 10 per cent. loss between the brake horsepower and the machine to be driven, to which may be added the loss in the machine itself due to friction. Total efficiency, 50 per cent., taking the lowest estimate of loss.

According to a consular report dealing with the trade of Denmark, milking by machinery has gained some ground during 1909, and about 150 machines, mostly of the pressure and suction type, are in use. At the same time, it cannot be said that this question has as yet found a satisfactory solution. Experiments have lately been in progress at a well-known Danish dairy farm, under the superintendence of representatives of the Royal Veterinary and Agricultural College of Copenhagen, with a view of comparing the relative values of hand milking and milking by machinery. The milking machine under observation was the Lawrence-Kennedy-Gillies milking machine.

The deepest vertical shaft in America at any gold mine is the Kennedy, at Jackson, California, which is 3450 feet. There are deeper shafts in gold mines at Bendigo, Australia, and on the Rand, South Africa. The deepest vertical shaft in the world at present is the Tamarack No. 3, near Houghton, Michigan. It is 5253 ft. deep, lacking 27 ft. of being a mile. No. 5 shaft of the Tamarack company is 5089 ft. deep. The deepest shaft of the Calumet & Hecla mine, adjoining the Tamarack, is the Red Jacket, 4920 ft. deep.

An installation of jet cooling sprays for handling approximately 27,000 gal. of condensing water per hour is in operation at the plant of the Cambria Iron & Steel Works, Johnstown, Pa. Condensing water is pumped to the spray nozzles through a 24-in. pipe. The system comprises cooling steps and horizontal pipe made up of 20 18-in. tees, each fitted with a 1½-in. Schütte & Koerting spray nozzle. Ten of the sprays are inclined at an angle of about 30 deg. and 10 at about 60 deg. with the vertical. The cooling slope, a series of concrete steps, is 72½ ft. wide and 124 ft. long. The water leaves the jets at a temperature of 120 deg. and is taken from the reservoir at 80 deg.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 2.

965,881. LANDING AND STARTING APPARATUS FOR AEROPLANES. George Otis Draper, New York, N. Y.

965,949. ACETYLENE-GENERATOR. Frank C. Sanford, Bridgeport, Conn.

965,963. BURNER FOR FUEL-OILS. Albert W. Thompson, Manchester, N. H.

1. In an oil burner, an atomizing chamber provided with a tangential inlet for the admission of air under pressure, and an axial outlet at one end of the chamber, an inlet member for oil under pressure, communicating axially with said chamber at its other end, and means to provide an annular jet of air concentric with and adjacent to the outlet of the atomizing chamber.

965,969. FLYING-MACHINE. Frederick H. Wales, Imperial, Cal.

966,032. HOT-AIR MOTOR. Guillaume Mann, Paris, France.

966,151. FLYING-MACHINE. Malcolm Grover Adams, Parsons, Kans.

966,211. AIR-BRAKE SYSTEM. Charles W. Hurl, Altoona, Pa.

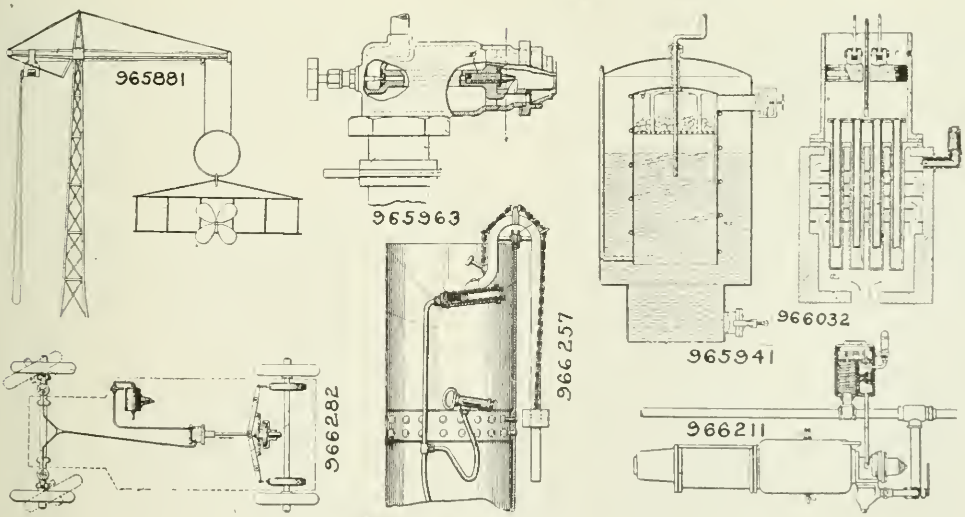
966,257. RIVET-HOLDING APPARATUS. William T. Smith, Birmingham, Ala.

966,282. AIR-BRAKE AND CLUTCH MECHANISM. William B. West, Philadelphia, Pa.

AUGUST 9.

966,424. MONOPLANE. Everard H. Boeckh, Toronto, Ontario, Canada.

966,494. AIR-COMPRESSOR. Gustav C. Vollmer, St. Louis, Mo.



Pneumatic Patents, August 2.

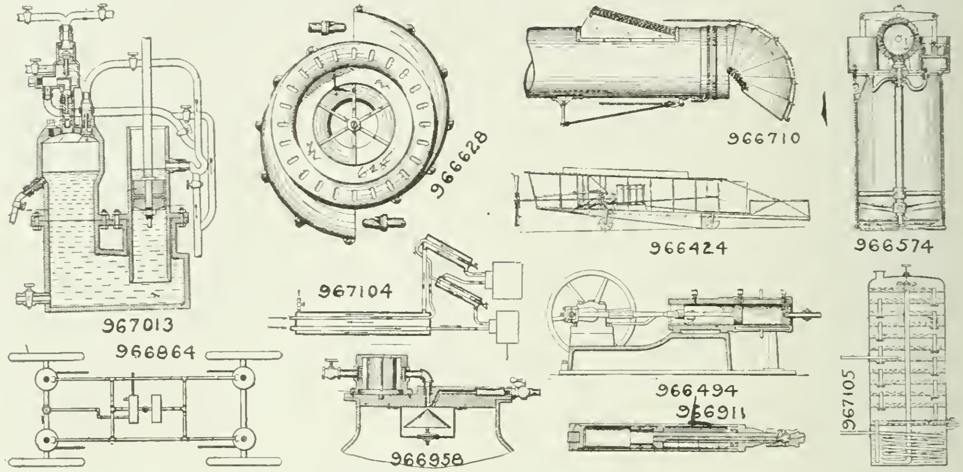
966,574. MACHINE FOR MAKING BUTTER. RODNEY MONTAGUE, Cincinnati, Ohio.

1. In a machine for making butter, a closed cylindrical vessel, having a central rotatable hollow shaft, with a series of air tubes radially projecting from the lower end of said shaft, and extending to the wall of the vessel, the lowermost air tubes having openings throughout their length opening downwardly to project the air against the bottom of the vessel and the uppermost tubes having openings at their outer ends to project the air against the side wall of the vessel, an air pump for forcing air through said shaft and air tubes and means for rotating said shaft and air tubes.

966,576. LIQUID-FUEL BURNER. WALTER R. MONTGOMERY, Shreveport, La.

966,628. BURNER FOR LIQUID FUEL. CARL W. WEISS, New York, N. Y.

2. A fuel oil burner comprising an annular flame guard provided with a tangential spray inlet port through which air and oil are supplied, and with lateral flame outlet ports, means to discharge additional air into the flame guard, means to supply oil under pressure in a liquid condition, and a spray jet nozzle to direct the oil spray under pressure into the spray inlet.



PNEUMATIC PATENTS, AUGUST 9.

966,710. PNEUMATIC STACKER. JOSEPH K. SHARPE, Jr., Indianapolis, Ind.

966,864. PNEUMATIC SUPPORTING MEANS. GUSTAF VON SCHANTZ, New Britain, Conn.

966,911. AIR-FEED FOR DRILLS. MARTIN HARDSOCG, Ottumwa, Iowa.

966,958. MILKING APPARATUS. FRANK B. SHAFER, Northville, Mich.

967,013. AIR-COMPRESSOR ADAPTED TO WORK AS A VACUUM-PUMP. ELIE GAUCHER, Constantinople, Turkey.

967,104. PROCESS OF LIQUEFYING GASES. GEORGES CLAUDE, Paris, France.

967,105. PROCESS FOR THE SEPARATION OF GASEOUS MIXTURES INTO THEIR ELEMENTS. GEORGES CLAUDE, *Nogent-sur-Marne*, and RENE JACQUES LEVY, Boulogne-sur-Seine, France.

4. A process for separating atmospheric air into its constituents, which consists in liquefying cold compressed air in a vaporizing compartment containing the liquid oxygen or liquid rich in oxygen which results from the separation, and is thereby vaporized, causing the liquid resulting from the said liquefying of the cold compressed air to descend by stages into the said vaporizing compartment, conducting part of the vapors ascending therefrom in the opposite direction to and in contact with the descending liquid to progressively enrich it in oxygen by the substitution of the oxygen of the vapors for the nitrogen of the liquid, and adding a cold gaseous mixture of oxygen and nitrogen, poorer in oxygen than the vapors immediately above the liquid in the vaporizing compartment, to the ascending vapors, at a point where they are of approximately the same composition as the aforesaid gaseous mixture, and at a pressure only sufficient to enable it to ascend, together with the aforesaid vapors, through the descending liquid.

AUGUST 16.

967,199. AUTOMATIC AIR-PUMP. JAMES A. KENWORTHY, Oakland, Cal.

967,234. FLUID-PRESSURE REGULATOR. THOMAS S. PUKERUD, Pittsburg, Pa.

967,239. FLUID-OPERATED ROCK-DRILL. CHARLES B. RICHARDS, Cleveland, Ohio.

967,245. ELECTRICALLY-OPERATED CONTROL MECHANISM FOR PNEUMATIC OPERATING DEVICES. HAROLD ROWNTREE, Chicago, Ill.

967,271. PNEUMATIC MOTOR. EUGENE T. TURNEY, Rock Island, Ill.

967,285. SHOCK-ABSORBER. CHRISTIAN WILSON, Brookline, Mass.

967,286. APPARATUS FOR AERATING LIQUIDS. JACKSON B. YOUNG, Oakland, Cal.

967,359. FLYING-MACHINE. ALBERT HUGO FRIEDEL, Baltimore, Md.

967,513. VACUUM AUTOMATIC MILKING-MACHINE. FLOYD B. GROFF, St. Johnsville, N. Y.

967,516. AUTOMATIC AIR-COUPLING. ARCHER H. HARRISON, Orange, La.

967,711. AEROPLANE. ROMAIN DE BERSAQUES, Washington, D. C.

967,731. SAFETY-VALVE FOR AIR-BRAKES. THOMAS B. COYLE, Ashley, Pa.

AUGUST 23.

967,885. MINING-MACHINE. CHARLES E. DAVIS, Chicago, Ill.

967,993. DUSTING APPARATUS. FRANK C. STEVENS, North Andover, Mass.

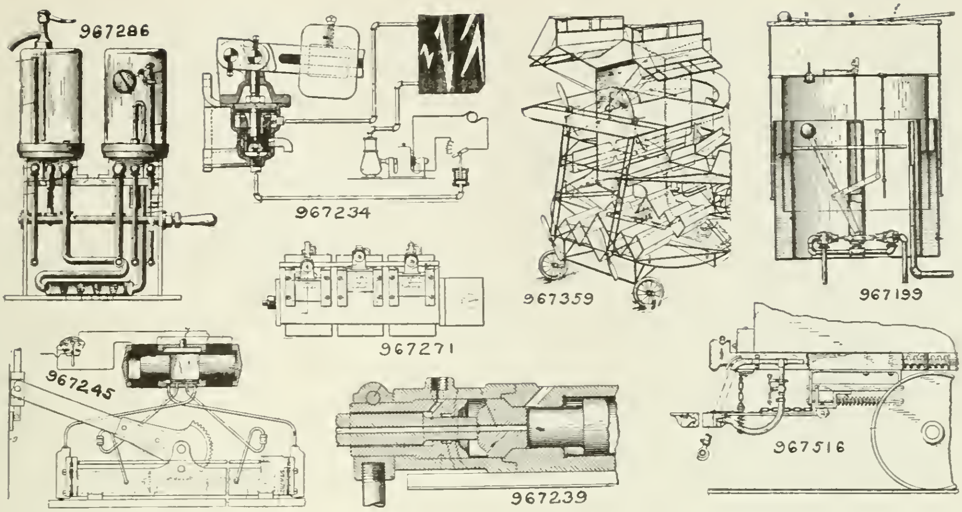
968,003. WINDMILL. ROBIN W. VAUGHAN, Los Angeles, Cal.

968,074. HUMIDIFYING APPARATUS. FREDERICK W. PARKS, Fitchburg, Mass.

968,094. COUPLING FOR AIR-BRAKE SYSTEMS. VIRGIAL P. TAYLOR, Richton, Miss.

968,120. FLYING-MACHINE. JACOB H. BUSS, Saltillo, Tenn.

968,141. PNEUMATIC-DESPATCH-TUBE APPARATUS. EDMOND A. FORDYCE, Boston, Mass.



Pneumatic Patents, August 16.

968,234. AIR - COMPRESSOR. Frederick Boercker, St. Louis, Mo.

968,236. PNEUMATIC HAMMER. Joseph E. Burtle, Springfield, Ill.

968,291. PNEUMATIC ACTION. Bartholomew T. Treahy, Detroit, Mich.

968,332. AIR-TREATING MACHINE. Charles E. W. Dow, Boston, Mass.

968,339. AEROPLANE LAUNCHER AND LANDER. Gerald Geraldson, Newcastle, Cal.

2. In an aeroplane launching and landing apparatus, an oscillatory suspending element, and pneumatic means connected with said element to permit paying out of and for taking up the same, said pneumatic means being adapted to act as a cushion on the paying out motion.

968,453. ELECTROFLUID-PRESSURE APPARATUS. Carl R. Daellenbach, Braddock, Pa.

AUGUST 30.

968,528. METHOD OF GENERATING OXYGEN. Andre Beltzer, Bridgeport, Conn.

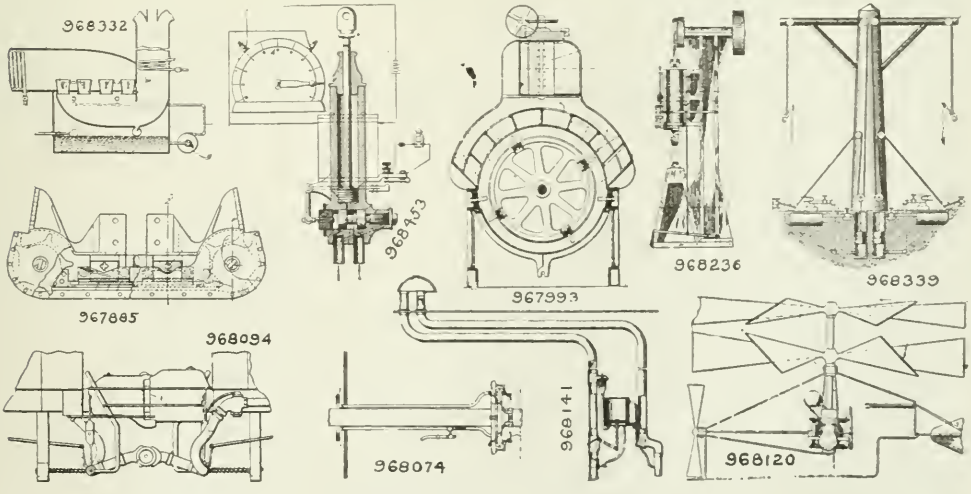
1. The method of generating oxygen which consists in heating a mixture of 66⅔ per cent. by weight of bleaching powder and 33⅓ per cent. by weight of slacked lime to a temperature of approximately 300 degrees C., substantially as described.

968,546. PNEUMATIC ACTUATING UNIT. Lamartine M. French and William M. O'Brien, Chicago, Ill.

968,560. MOLDING-MACHINE. Martin L. Heyl and John J. Lawlor, Zelienople, Pa.

968,567. TERMINAL FOR PNEUMATIC-DESPATCH TUBES. Chester S. Jennings, Brookline, Mass.

968,576. PNEUMATIC-DESPATCH-TUBE APPARATUS. Charles R. Libby, Lowell, Mass.



Pneumatic Patents, August 23.

968,577. AUTOMATIC SWITCH FOR PNEUMATIC-TUBE APPARATUS. Isaac W. Litchfield, Boston, Mass.

968,580-1. PNEUMATIC-DESPATCH-TUBE APPARATUS. James G. Maclaren, Weehawken, N. J.

968,598. PNEUMATIC-DESPATCH-TUBE APPARATUS. Albert W. Pearsall, Lowell, Mass.

968,607. PNEUMATIC PAD FOR HORSE-COLLARS. Walter Avery Skillman, Springfield, S. D.

968,614. PNEUMATIC CARRIER-SEPARATOR. Harold D. Waterhouse, Quincy, Mass.

968,642. BELLOWS-LIKE HYDRAULIC AND PNEUMATIC MACHINE AND APPARATUS. Pierre Brandt, St. Petersburg, Russia.

968,700. FLYING APPARATUS. Julius Schulke, Jena, Germany.

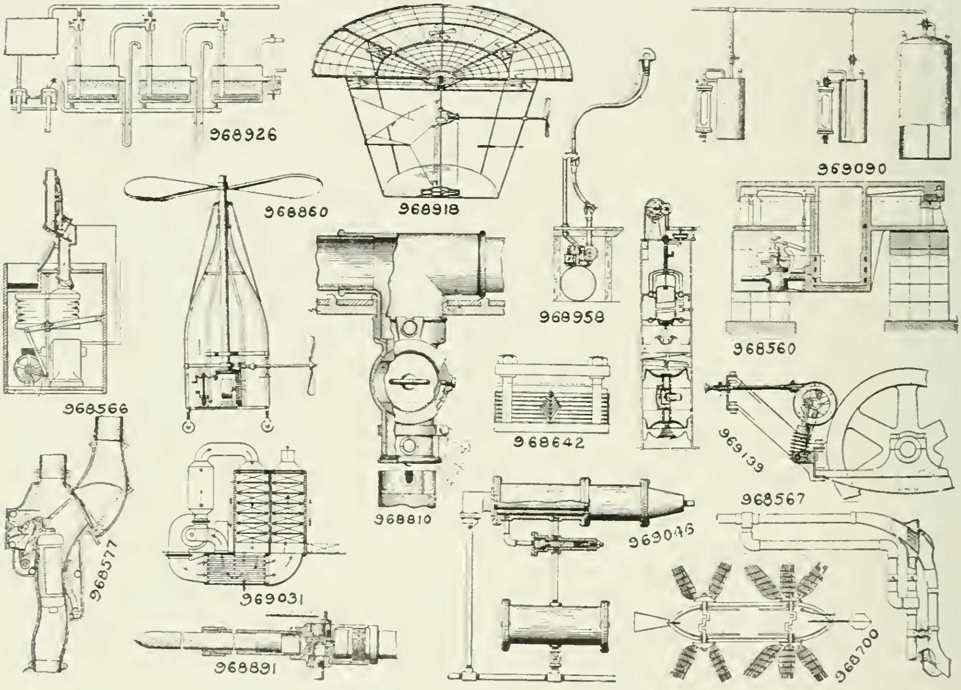
968,732. TIRE-PUMPING ATTACHMENT FOR AUTOMOBILES. Oscar M. Bergstrom, Minneapolis, Minn.

1. The method of compressing gas which consists in raising its pressure in successive stages by acting on the gas with a steam jet to impart velocity to the gas and then converting the energy of velocity of the gas into energy of pressure at each stage, and in condensing the steam employed at each stage, and separating the condensed steam from the gas before delivering the latter to the following stage.

969,031. PROCESS OF AND APPARATUS FOR DRYING WET MATERIAL. Wladislaus Bratkowski, Berlin, Germany.

1. The herein described process of drying material consisting in forcing a current of air in a cycle through the material to be dried, imparting heat to the air just before it enters the material, transferring heat from the air as it leaves the material to a second current of air, and passing said second current through another portion of the material after the transfer.

969,046. AIR-BRAKE SYSTEM. Arthur Doan, Elmhurst, Cal.



Pneumatic Patents, August 30.

968,734. AEROPLANE FLYING-MACHINE. John M. Biggs, Dayton, Ohio.

968,810. CONNECTION FOR PNEUMATIC APPARATUS. Ira H. Spencer, Hartford, Conn.

968,860. FLYING-MACHINE. Frederick B. Kummer, Sheboygan, Wis.

968,861. PNEUMATIC-VALVE MECHANISM. Knut Ivar Lindstrom, Nykvarn, Sweden.

968,891-2. HAMMER-DRILL. Albert H. Taylor, Easton, Pa.

968,898. APPARATUS FOR FILLING BOTTLES WITH AERATED LIQUIDS AND BEVERAGES. Hubert Leslie John Torpy, Jolimont, Melbourne, Victoria, Australia.

968,918. FLYING-MACHINE. Charles E. S. Burch and Frederick R. Burch, Seattle, Wash.

968,926. METHOD OF AND APPARATUS FOR COMPRESSING GAS. Adalbert W. Fischer, Philadelphia, Pa.

969,073. OXYGEN-BATH. Otto B. May, New York, N. Y.

1. A composition of matter of the character described, comprising means adapted, on contact with water, to set free hydrogen peroxid, a catalytic agent adapted to break up the hydrogen peroxid, and a finely divided insoluble inert carrier which is impregnated with said catalytic agent, said carrier adapted, upon chemical action between said peroxid and said catalytic agent, to retain said catalytic agent and prevent objectionable precipitation thereof and disagreeable discoloration of the bath liquid.

969,090. LIQUID MEASURING AND FILLING APPARATUS. George W. R. Culbertson and Sylvanus R. Clark, Glezen, Ind.

969,123. APPARATUS FOR COMPRESSING ELASTIC FLUIDS. Claude Houston Stuart and Charles Scott-Snell, London, England.

969,139. AIR-COMPRESSOR. Joseph W. Eberman, Chicago, Ill.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XV NOVEMBER, 1910 No. 11

THE SAND HOG

He's fifty inches round the chest,
His leather lungs are sound,
His heart must stand the air compressed
In caissons underground;
With pressure hammering his ears,
His shovel in his hand,
He works—in several atmospheres—
And burrows in the sand.

Beneath the "lock"
He spends his time;
He seeks bed-rock
Through silt and slime,
And blithely takes
His chances where
For us he makes
A Thoroughfare!

The job would never have a start
Without the Draftsman's wit;
The Ironworker does his part,
The Mason adds a bit;
They do their work—remember that—
But also please recall,
The Sand Hog certainly is at
The bottom of it all.

When he is through,
Right on his heel
May come the crew
With stone and steel;
But till he's done
They wait their day,
For he's the one
Who clears the way.

The Engineer says "Go ahead!"
The Sand Hog wiggles down
In tunnels through the riverbed
Or subways in the town;
Through quicksand, gravel, rock and mud—
With death itself to dare
From falling rock or sudden flood—
He digs a Thoroughfare.

When moisture seeps
Through chink and crack
And all that keeps
The water back
Is air—just air—
He doesn't shirk,
The job is there—
And that's his work.

Because he toils and sweats below,
In steam and dripping heat,
The tall steel buildings rise and throw
Their shadows on the street;
For tubes in which the millions ride
To do their work each day,
For bridges flung across the tide,
The Sand Hog clears the way!

—Berton Braley, Saturday Evening Post.

THE CONTAMINATION OF CITY AIR

By Dr. George A. Soper.

[The following is a portion of a valuable and highly interesting address by Dr. Soper before the Boston Society of Civil Engineers, printed in the Journal of the Association of Engineering Societies. The opening paragraphs are here omitted; another portion, which we think still more interesting, will be printed in our next issue.]

The changes of opinion with respect to the cause and prevention of disease which the new knowledge, especially of bacteriology, physiology and chemistry, has produced, have been revolutionary. The entire basis upon which the sanitation of cities should rest was changed when it was discovered that infectious diseases could not originate in filth and foul odors, as had always been supposed, but were ascribable in every instance to some pre-existing case of disease, just as the existence of a grain of wheat is ascribable to some other grain of wheat which has gone before and served as seed.

It is interesting to note that in the progress of sanitary science nothing has occurred to shake the opinion that the air we breathe is by all means the most important single matter to which sanitarians can give attention. As a recent anti-tuberculosis campaign poster put it: "Man can do without food for three weeks, and without water for three days, but he cannot do without air for more than three minutes."

There is a singular difference between our requirements for air and our need of other life-sustaining elements. We are generally much less fastidious about the composition of our air than about the composition of our food and drink, and yet health and efficiency are profoundly affected by the quality of the 400 cu. ft. or so of air which we daily take into our lungs. Send your pale city man to the country and see the visible improvement in energy, spirit and strength which he at once experiences.

The evil effects of bad air are not so immediately apparent. They are generally hidden for so long that the victim comes to believe he is immune, or that the danger has been exaggerated. But eventually the price is paid.

Air, like water, is, in natural condition, pure. It is to man's use of it that the most harmful attributes which it sometimes possesses are due. So far as the essential gases are concerned, the atmosphere of the prairies is as pure as that of the sea, and the air of the marshes is as wholesome as that of the mountains. In the open there is as much oxygen in one place as in another. Much of the difference in chemical composition which seems to exist is due to differences of temperature and humidity, and the effect of various conditions acting agreeably or otherwise through the senses of sight and smell. The point most worth bearing in mind in considering this question is that under the natural conditions which exist in the free, open atmosphere of the country there is always enough oxygen for life and health, and rarely any other gases which can do either good or harm. It is the air of cities, and especially the air of inclosed spaces, that is likely to be contaminated.

It is doubtful whether ozone actually exists in the atmosphere. Sir William Ramsay has expressed the opinion that it does not exist. Yet the scientists of the Montsouris Observatory of Paris make determinations of what they consider to be ozone regularly, and we have in New York City, in Central Park, an observatory where Dr. Draper has been making what he considers to be ozone determinations for a long time. We have recently had ozone recommended as an air purifier. A few years ago, in the Paris subway, I saw an ozone machine, a machine for throwing ozone into the atmosphere in the hope of improving the condition of the air. Ozone is a curious form of oxygen which produces an opposite effect—at least, when fairly concentrated—to what one would expect of a healthful agent. It produces the symptoms of influenza, as I can testify, having experimented considerably with it in the laboratory in experiments to sterilize water. Professor Leeds, of Stevens Institute, had to give up experimenting with ozone entirely because of its unpleasant effects.

The air impurities which are worthy of notice do not belong to any one class or group of substances, as do the water impurities which affect health. Aerial contamination may be chemical, physical or microbic. By chemical impurities is meant chiefly the gaseous products of industrial works, compounds produced in the combustion of coal and illuminating gas. It is unnecessary to make extended mention of the effects of these gases, although the fact should be noted that carbon monoxide, a prominent ingredient of the gas which is produced when coal and other carbonaceous matters are burned with an insufficient supply of air, is a powerful poison, which not infrequently causes death in mines and elsewhere. Methane is the greatest danger of mines. It is produced when organic matter is decomposed in the absence of air and presence of water. Sewage septic tanks give it off, for example. Methane, like carbon dioxide, destroys life by diluting the oxygen present. There must be a large proportion of it to affect one seriously. It is explosive when mixed with about ten times its volume of air.

There is no gas known to science as sewer gas, the ghost which formerly went by that name and was supposed to creep with deadly effect into dwelling houses through plumbing fixtures having been laid years ago. Sulphureted hydrogen, methane and carbon dioxide are often present in the air of sewers, as is the much more dangerous illuminating gas and gasolene vapor. These two have from time to time caused startling explosions in the sewerage systems of New York and other cities. The Metropolitan Sewerage Commission of New York, to which I have the honor to belong, has made a systematic inspection of the sewers of Manhattan Island in co-operation with the Department of Public Works, and one of the specifications which we made in that co-operation was that our men were not to be sent down in what is called the gasolene district.

Turning to gaseous impurities due to the presence of human beings, it is reassuring to know that air which has passed through the lungs possesses practically no poisonous properties of chemical composition in spite of the teachings to the opposite effect which are a favorite theme of text-books. The unpleasant odors are objectionable chiefly because they are unpleasant. Perhaps that statement should be qualified to this effect, that although every effort has been made by scientists for years to detect the presence of poisonous products of respiration, those efforts have been without success. Some years ago a number of men who became somewhat famous as a result of their researches came to the opposite opinion. They believed that gaseous poisons were produced by breathing air. But we know now that their technic was imperfect and that the animals that were experimented upon were poisoned otherwise than by products of respiration.

The air of an overcrowded and badly ventilated room is slightly lacking in oxygen, but the deficiency is generally not great and under ordinary circumstances is readily compensated for by an imperceptible acceleration in the rate of breathing. Accelerations of far greater extent than any which are likely to be produced by a deficiency of oxygen due to bad ventilation take place upon the slightest exertion in any atmosphere.

Air which has passed through the lungs is loaded with vapor and with carbon dioxide, but in view of the harmless nature of the latter gas its presence need not, under ordinary circumstances, be considered of great importance. The danger of chemical poisoning through breathing an atmosphere charged to the extent of one part of carbon dioxide in a thousand parts of air, which is the limit often set by law for factories and workshops, seems trivial when we consider the quantities of undiluted carbon dioxide which are taken into the system with tobacco smoke, beer, mineral waters and sparkling beverages generally. The sanitary significance of carbon dioxide lies in the index which it affords of the presence of other and more dangerous impurities of human origin. Tests of air for carbon dioxide are like tests of water for chlorine,—they furnish a clew to the presence or absence of harmful microbes.

The free atmosphere, that is, the air out of doors, possesses a sensibly beneficial quality which has baffled the keenest investigators to explain and it cannot be produced artificially. Some years ago a number of scientists were appointed to examine the air of the meeting rooms of the Houses of Parliament. They were given liberty to choose the most refined methods of analysis, and were instructed to determine why it was that the ventilation of those rooms was not satisfactory. The scientists reported that the cause of the unsatisfactory condition of the air could not be determined, but that there was a perceptible lack of freshness about the atmosphere. That freshness, the quality which we all have noticed in going out of doors, can never be obtained in a completely inclosed room. It is at once the ambition and the despair of ventilating experts to bring about such a condition. It seems to be impossible even to account for it.

The microbic poisons which air sometimes contains are by all means the most directly dangerous impurities which are likely to be present. They are the inciting cause of tuberculosis and pneumonia, which, together, produce more deaths than any other disease or group of diseases to which man is liable. The forms of sickness which are transmissible by air include nearly every contagious and infectious disease which occurs in our northern climate, except the disease which has the distinction of being named bad air, or malaria.

How disease germs get into the air, how long they survive and how they fasten their infinitesimal personalities upon their unwilling hosts, is a subject of fascinating interest, but one which we can notice here only in the briefest terms. Everything is not yet known about this subject, by any means. A few facts, readily understood, are worth keeping in mind for the sake of the simple precautions to which they point.

The sputum of persons suffering from respiratory affections contains the infectious germs of their diseases in large numbers, and it is desirable that this material shall at once be rendered inert by disinfection, preferably by burning, in order that its poisonous nature shall be destroyed. In a dried state these germs may persist for weeks, although it is doubtless the fate of most of them to perish under such natural influences as desiccation and sunlight within a brief time.

It seems unnecessary to mention the fact that the sputum in tuberculosis and in pneumonia may remain capable of producing tuberculosis and pneumonia when inhaled by persons who are in a receptive condition. And yet that point has been disputed. Evidently the crusades which the tuberculosis experts have been making have not converted everybody. In experiments which I have made I have found that the germ of pneumonia may remain viable for twenty-one days when kept indoors, and be destroyed out of doors, in the streets, within four or five days.

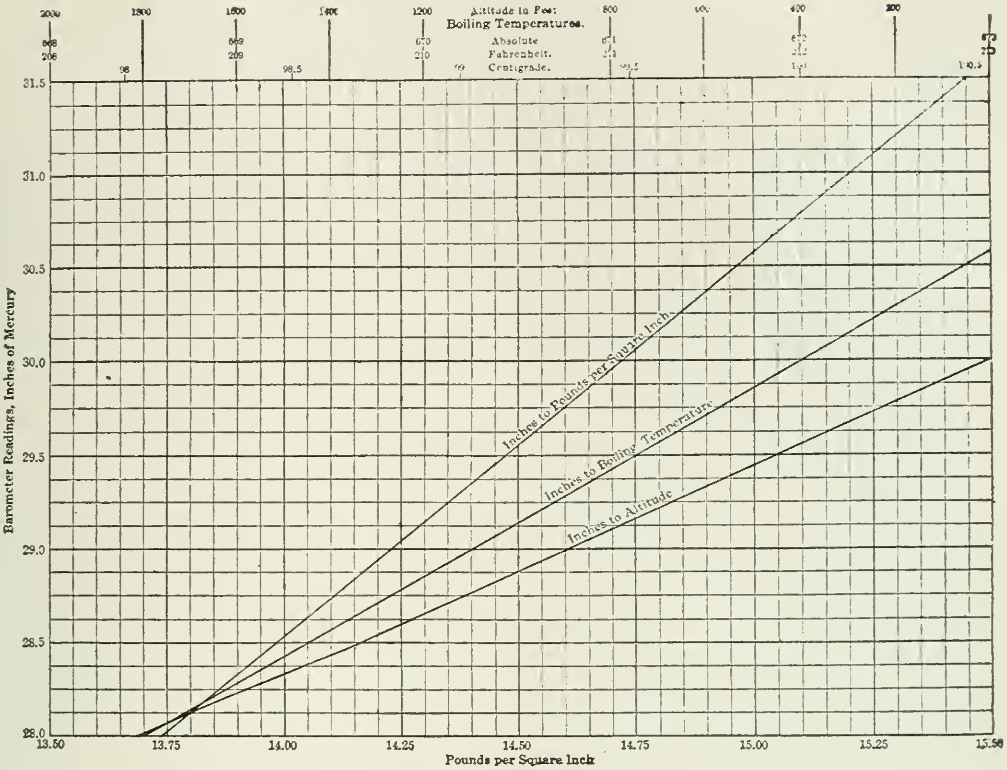
It is not considered, however, that tuberculosis and pneumonia are most often contracted by breathing germs which have been dried and raised from the floor or the street in the form of dust. Hygienists are coming to the opinion that the destruction of most species of pathogenic bacteria proceeds rapidly outside of the favorable environment of the body, and that the transmission of disease germs from person to person generally takes place in ways which are comparatively short and direct. This view is reasonable and reassuring and goes far to compensate for the disquieting results of some recent investigations, which show that bacteria may be projected into the air from wet surfaces and under favorable conditions of temperature and moisture retain their normal characteristics for considerable periods of time. For example, sewer air has recently been found to, at times, contain bacteria which have become separated from the sewage by splashing, by the bursting of bubbles and by the alternate wetting and drying of exposed surfaces.

More important to most of us is the danger of germs thrown into the atmosphere by persons in the acts of coughing, sneezing and speaking. It has been found that in these natural and apparently innocent performances minute particles of saliva are ejected in great number, and that these droplets often contain bacteria. The moisture soon evaporates, leaving the germs free to keep afloat in air currents or gradually subside like motes of dust. Cough spray, as this fusillade of germs is called, may be highly poisonous, for not only are the bacteria which it contains thrown into the air in a perfectly fresh and virile condition, but they are relatively concentrated. Fortunate it is that so few of the countless species of bacteria which exist are capable of causing disease, yet the fact that the mouth is the normal habitat of at least a half dozen kinds of germs, and is sometimes the abiding place of diphtheria bacilli and other pathogenic species, considerably modifies the comfort which we can take in this reflection.

AMERICAN SUPREMACY IN COAL MINING

From figures on the world's coal supply, in a recent British publication, the Bureau of Manufactures of the Department of Commerce and Labor has compiled statistics, showing that the United States, with 690,438 persons employed in mining coal in 1908, produced 126,562,000 tons of coal more than were produced by 966,264 persons similarly employed in the United Kingdom, and that the production of coal in the United States amounted to 538 tons per person employed, as against 271 tons produced per person in the United Kingdom. Based upon reports of 1908 and 1909, the total production of coal in the United Kingdom, the United States, Russia, Sweden, Germany, Belgium, France, Spain, Austria, Hungary, and Japan for 1909, was estimated as 958,674,000 tons, with a total value at the pit of $1,854,323,893, and an average value per ton of $1.93. The number of persons employed in producing the coal was 3,172,110, and the average number of tons produced per person 294.

In regard to the coal consumption of the several countries the report says: The consumption of coal in the United States is more than twice as great as that in any other country, and nearly equals the combined consumption of the United Kingdom, Germany, France, and Belgium, and is actually greater per capita than in the United Kingdom.



A BAROMETER CHART

The accompanying chart, originally contributed to the page of *Power and the Engineer* by G. A. Glick, is designed to facilitate the transformation of barometer readings in inches of mercury into equivalent pounds per square inch, to show the corresponding boiling temperature of water at any barometer reading and to find the altitude corresponding to any barometer reading. The chart is plotted only between 28 and 31.5 inches of mercury, for the reason that the larger number of calculations come within this range, and the small range permits considerable accuracy, that otherwise would not be obtainable. The scales used are all rather fine and this will permit close readings, which are liable to be more accurate than can be obtained on a slide rule. The spacing for the mercury readings is in eighths of an inch, which unfortunately does not correspond very well with the decimal figuring, but need not be misleading.

A few constants are given to permit calculations beyond the limits of the chart. With regard to altitude it may be said that, as a rough approximation, the pressure of the atmosphere decreases one-half pound per square inch for every 1,000 feet of ascent, or in descending toward the center of the earth the barometer readings increase by 1 inch of mercury for every 900 feet drop. To change inches of mercury to pounds per square inch, the well known rule of multiplying the reading in inches by 0.4908 gives the corresponding pressure in pounds per square inch. Roughly speaking, pure water will boil at 1 degree Fahrenheit less for every 550 feet ascension up to an elevation of one mile, after which the increment becomes 560 feet.

The chart can be used interchangeably, that is, pounds per square inch can be used instead of inches of mercury to find the corresponding altitude and boiling point, or even the barometer reading, if it is desired. In this case all the values would have to be reduced to inches of mercury as a common standard. For example: Suppose the barometer reads 29.925 inches of mercury. Looking on the chart at this reading we find the corresponding pressure to be 14.68 pounds per square inch. The altitude corresponding to this barometer reading is 70 feet, and water will boil at 211.87 degrees Fahrenheit. Care must be taken that each reading is taken from the proper curve plotted for that condition.

MEASURING AEROPLANE ALTITUDES

By Augustus Post.*

To obtain the altitude of Mr. Brookins' (Wright) aeroplane at Atlantic City, for the National Council of the Aero Club of America the first thing that was done was to lay off a base line of sufficient length so that the angles observed through the surveyors' transits would not be too great when the aviator crossed this line at his highest point.

Such a base line was laid out running from the outer end of the Atlantic City steel pier to a point on the board walk, near Tallahassee avenue, about two miles and a half distant. A boat was anchored midway along this line so that the aviator could tell the point at which to cross the base line.

The exact length of this base, which was obtained by triangulation and the use of the measurements of the Atlantic City monument system, was found to be 13,394.29 feet, which is undoubtedly correct within a narrow margin.

Two surveyor's transits were set up, one at each end of this line as a base; each telescope was pointed toward the other station and clamped in that vertical plane, although movable in altitude in that plane. The question might be asked as to why it was necessary to have the telescopes clamped in the line between the two stations, thereby requiring the aviator to cross this line when at his highest point, if his highest altitude was to be recorded, in view of the fact that an engineer's transit will measure angles in azimuth as well as in altitude. John W. Hackney, of the firm of Ashmead & Hackney, civil engineers, of Atlantic City, under whose direction the engineering problems were worked out, has ably answered this question in his official report as follows:

"This might possibly be the best method, i. e., to move the telescopes in azimuth also, if the aviator, having reached his highest point, could stop his aeroplane for a moment and then signal both observers to note his position. But this cannot be done. He himself might not know just when he was at his greatest elevation, and it is quite certain that he could not momentarily stop his machine; but assuming that he did know and did give a signal, we must still assume, since he cannot remain still, that both observers have the aeroplane within the telescopic field of view at the moment the signal is given. This means that each telescope must be kept continuously upon the aeroplane by moving it steadily and continuously both in altitude and azimuth. This motion, unless the object is very far off, may be too rapid for slow-motion tangent screws, and in any event the range of continuous motion by the tangent screws is quite limited. An actual attempt will quickly convince the observer that such a method is impracticable.

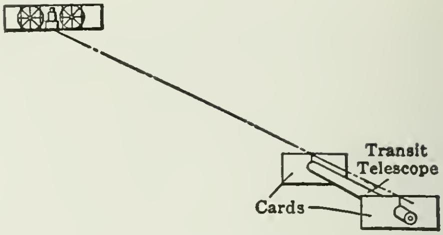


Fig. 1. Cards for Sighting Outside of Telescope Field

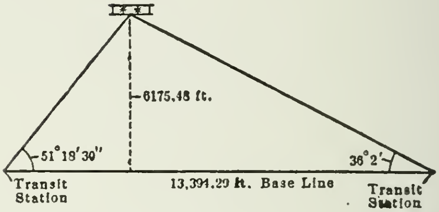


Fig. 2. The Triangulation of Altitude

"The same reasoning will show that the firing of a pistol by some observer as a signal when the highest altitude has been reached, and when observations are to be taken, or the making of simultaneous observations at stated moments by reference to synchronized watches, is impracticable, since both methods presume that the object is within the field of view at the precise moment the signal, or order to observe, is given.

"The establishment of a vertical plane pass-

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*Official recorder for the National Council of the Aero Club of America.

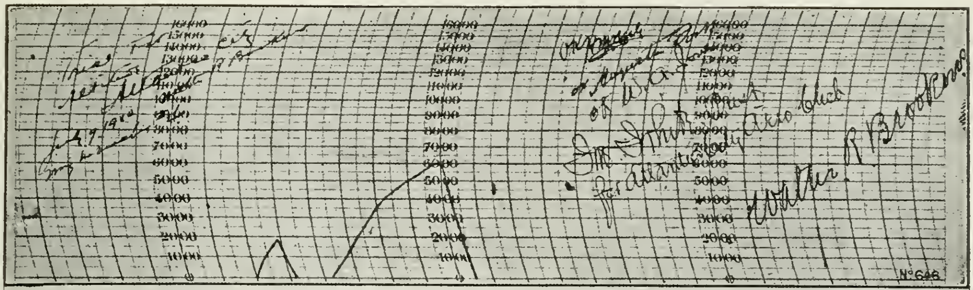

FIG. 3. FAC-SIMILE OF RECORD OF ALTITUDE REACHED IN AEROPLANE FLIGHT BY WALTER R. BROOKINS, ESTABLISHING THE WORLD'S RECORD. CHART TRACED BY RECORDING BAROMETER

ing through the instrument stations simplifies the problem, if the aviator passes through it approximately at right angles thereto, since the observations which must be made by both observers while the object is in the field of view must be practically simultaneous, which is, of course, a necessary condition.

"The work of the observer is reduced to the maintenance of his instrument in proper level, and the single observation of altitude. This, so far as the pointing is concerned, is quite a problem, since the telescopic field is small, and unless the observer has his telescope at the correct altitude he may, and probably will, miss the transit of the object altogether. To avoid this, range sights were attached to the telescope of each instrument. These were rectangular strips of stiff cardboard 3½x8 inches, two for each instrument.

"In the center of each card was cut out a circular hole; one card was slipped over the object end of the telescope, removing the sunshade for this purpose and then replacing it, and the other was fitted to the eye end. These cards were leveled by ranging with the horizon. A black line was ruled on each card midway between the ends to act as a sight for the telescope. A plane resting upon the top edges of the two cards would be parallel with the horizontal axis of the telescope.

"The telescope was moved in altitude so that the upper edges of the two strips of cardboard were in range of the aeroplane. This range was closely maintained by moving the telescope up and down with the left hand, while the right hand held the clamping screw. The eye was kept likewise in range with the aeroplane and the vertical black line on the card nearest the eye. Just before this line and the line on the object end of the telescope came into range, the telescope was clamped, the right hand was quickly transferred to the tangent screw and the eye to the telescope.

"If the aeroplane crosses the line at a reasonable distance from the observer, and in a direction at right angles to the line, there is no difficulty in getting an accurate sight; but if he is too near, or the angle is too acute, the observer may miss the transit altogether, since the altitude of the aeroplane is changing with great rapidity."

The angles read at the moment of crossing the base line on the particular occasion when

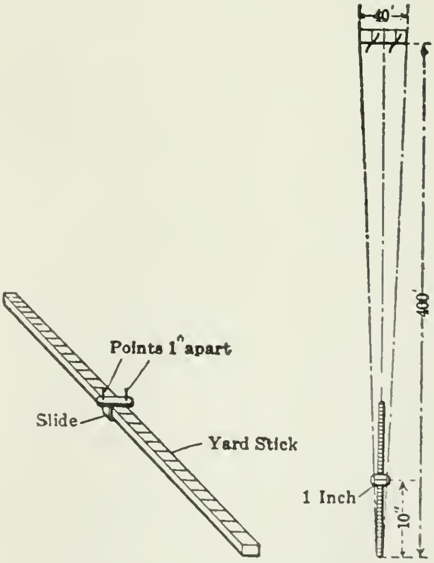

FIG. 4. YARDSTICK METHOD USED BY WRIGHT BROTHERS

Mr. Brookins was at his highest point were 51 degrees 18 minutes 30 seconds at the steel-pier station and 36 degrees 2 minutes at the other station. These angles being known, with a known base it was possible to figure out the altitude, which was 6,175.48 feet above mean sea level.

In this case the aeroplane itself was fitted with a Richards recording barometer, which registered automatically a height of 6,200 feet, as seen by a chart which is reproduced. This is a very good check on the surveyors' calculation, and shows how the ordinary balloon practice may be of value to the aeroplanist.

The Wrights themselves use a very simple and rough, but remarkably accurate, method of obtaining altitude. A man lies on the ground, on his back, and sights along a yard stick held directly above his eye. There is a slide on this stick, with two points just one inch apart. When the aeroplane is directly over the observer, this slide is moved along the yard stick until the points are in line with each end of the aeroplane, which is known to be 40 ft. wide.

If at this time the points on the slide are 10 inches from the observer's eye we have an equation which would be: 1 inch is to 10 inches as 40 feet is to x feet, or $x = 400$ feet.

Altitude measurements will be of the utmost importance in finding the range of an aeroplane in time of war, and to catch sight of a moving object is very difficult with instruments designed for fixed objects. Great angles may be read by means of solar transits, or mountain theodolites, and instruments fitted with prismatic eyepieces, but these are not easily obtainable.

One old sailor even calculated that Brookins was at an altitude of about 6,200 feet, by means of his antique quadrant, and said he could come closer if he knew just how wide the aeroplane was.—*American Machinist.*

PNEUMATIC TOOL EXPERIENCES

The folowing stories of experience were called out at the summer meeting of the Railway Tool Foremen's Association:

J. T. Fuhrman: I want to tell of a little experience. I was to do some repairs on the line. We repaired all of the air hammers, and we did the work as good as possible—just as we do in St. Paul, and we have very little trouble. There was one instance that was reported to the office; the hammer would not work any more, it was too weak. I examined the hammer and found it was all dry; the piston was gound off so it was loose. The man who repaired the hammer did not lubricate it; the piston stuck and he took the piston to the emery wheel and ground the piston; the air blew through and he lost the effect of the stroke. That shows what will happen when a man does not understand how to handle a hammer, and the toolman gets the blame for it. The care of the hammer is just as important as the repair of the hammer.

A. W. Meitz: I think it is about three weeks ago; we had a No. 90 hammer that suddenly gave out and would not work. A man took it apart and it hit a blow, but not hard enough. We did not see anything wrong, and we opened a little valve. We found the nut and the safety plug, but no little valve. We did not know what had become of it. The hammer was together solid, the lock nut was in four pieces. I think nobody could take that out and replace it again, because it would be a hard matter to bring that back in there. We came to the conclusion that the valve broke and went in to the piston. We repaired that and it has been running ever since, and we have had no trouble with it. It is a mistake to take a pneumatic tool out of a tool room and run it as long as it will run. Look out that you get your tools back once a week at least, if not every night. It isn't the fault of the manufacturer: it is always the use of the tool that causes the trouble.

J. H. Simons: I think we have a great deal of trouble with the pneumatic tools owing to the fact that the men who are using the tools never knew anything about machinery during their natural life. I have been a boiler maker all my life. A boiler maker in a boiler shop never has anything to work with but a solid piece of iron in the form of a sledge—something that is solid and indestructible, and he does not appreciate the fact that a hammer or drill needs some oil. We never had to put any oil on the riveting hammers. All the oil needed was inside of them. They seem to look at the pneumatic tool in the same light to-day.

Another class is the "Hunkey laborer." He never did know anything at all. I had to go to work when I was 14 years old and have worked twenty-four years. I have had charge of railroad shops and contract shops, and when I used to get hold of a pneumatic tool I never stopped to consider that it needed anything more than the other hammer, and about all that got was a little grease. It is up to the foreman to educate the men so they will know how to keep these tools clean. I have seen them take a hammer and knock a chip off. They seemed to think it ought to run as long as they brought it up. The machinist who knows how to use tools will oil them once in a while, but the boiler maker squirts some oil on the end of the twist drill when he sees the smoke come from it. I used to slam a tool down and tell them it wouldn't work, but I know a little bit different now. The men have to be educated to keep the tools clean in order to keep them running. If you do that, you will have little trouble with tools.

Secretary Harroun: I want to relate a little experience with the boiler makers. They don't mind being called mules; they like it. I believe the secret of the whole thing is that they do not like to use the hammer. They may become better reconciled to the use of it than when they first started to use pneumatic hammers. I at one time had some men prossering flues. They were breaking as many by expanding the flues as I could make, and I thought I would try to stop it. I got a No. 90 hammer and I made a taper pin that would just stick out and that was all. I took it to the boiler maker who was expanding flues and asked him to try it. "Not on your life; do you think I am a mule or an elephant. If they want me to rivet they will have to put a derrick up to hold it, and a man to operate the derrick." It occurred to me that there was something radically wrong that they did not care to use these things; but I have since been told by boiler makers who talked to me in apparent candor that they liked them; that they would not go back to the old way of riveting under any circumstances.

In regard to the care of the tools: The boiler maker is very differently situated from the machinist. He has to contend with more difficulties. He has to work in the boiler front end or in the fire-box, where the light is poor. If he throws the hammer down and breaks the trigger, he really isn't so much to blame. I have more charity for the boiler maker than I have for the machinist, because the machinist is outside. But the boiler maker who will take a hammer, and when you have put on one strainer after another on the end of it and doesn't blow his hose out and the hammer won't work and he knocks a hole through the strainer to be sure he is getting lots of air; he is the fellow I don't like.

Speaking about motors, when a motor leaves my department I know that it is all right. If it is sent to Kansas City, or any outlying point, we do the repairs for all the points. One day last week I had a motor come in. There was a letter addressed to Peter Maher, superintendent of motive power, which said in substance: "This motor was sent on train so and so to Bloomington for repairs; sent back to all appearances without any repairs being made on it. The motor doesn't work any better now than it did before. Kindly take this matter up with your tool foreman and see if that is the way they handle their business." Or something to that effect. I was satisfied in my own mind that the motor was all right because the man that I have on air tests had made the tests on all those things before it left the shop. I knew there must be something wrong out there with the air hose or pressure of air. I took the motor which was lying on the floor and I said to a man: "Try that motor." He put the air on it. I told him to put in a half inch twist drill, in the end of the socket put a piece of iron and put the pressure on it. That is the only way I do the testing. He drilled in a very short time through a one-half inch piece. I immediately went to my desk and I wrote a letter stating that to my mind it would be well to place some manner of instructions as to the care of pneumatic tools in these outlying shops. To have apparently intelligent men jump at conclusions and send letters of that character which reflected upon my department was not very pleasant. I do not know what they did. The machine went back and I have heard nothing from it. This is the condition the tool men are up against. They will place a tool in service or couple it up to a hose, and never stop to think that there is a possible chance for the hose to become clogged up, or that they ought to blow a hose up before coupling up to blow the scale and dust out. You may talk as I have often done to boiler maker foremen to do so and so and save a lot of trouble, but they say, "I will take it up." But the railroad goes on just the same, with total indifference, but the time lost by bad management of tools reflects back to the tool room foreman.

E. J. McKernan: I would like to give a little experience. When Dr. Derby was handling the tool room there was a motor sent in from Texas from a main shop on the Gulf Line, a No. 5 Little Giant wood boring machine. The motor was bone dry. He called my attention to it. The machinists in a good many cases are as bad as the boiler makers. I have been a machinist and had some experience in boiler work too, but machinists nowadays are severe. They throw a motor down from the top of a locomotive and it caves in the cylinders. In our main shop they have a kind of sub-tool room where all the air hammers, hose and various boiler maker's tools are kept, because the boiler shop is an off-set of the main erecting shop, and we do not want them to cover any more ground than necesary to get the tools and return them. The man in charge of this tool room happens to be a boiler maker's handy man. He has a vat that is filled with coal oil that is turned off in the evening on account of the insurance, and he soaks all the hammers in that. But before each motor or hammer is turned out it is thoroughly oiled, regardless of how many times a day. No. 1 is turned out and Jones has it an hour or two; then it gets oiled again, but where they are out in the shop they do not get oiled until evening. We have a man go round and oil them up. The tool man in the boiler shop has a "shot gun" there and gives them an injection twice a day. It has prolonged the life of hammers two to one. We have motors to run hot, but we cannot get around that.

On Saturday night we have an air man who goes over all the motors, looks at the mechanism of them and oils them regardless of the man downstairs in the supply department. We have cut down our air tool expense quite a bit and it saves kicks to the manufacturers we buy from, because it isn't their fault. We know just exactly what horse power they are and when a man sends one in and wants it tested we stick it on the test rack. If it only shows 50 pounds, we realize it has only one-half the power it should have.

Natural gas is used for fuel on the locomotives of the Texas, Arkansas and Louisiana Ry. The gas is carried in a tank on the tender, sufficient tank capacity being provided for six hours' run. The road has two locomotives and one car, and is credited with eight miles of track.

AN ELECTRIC GAS, AIR OR STEAM METER*

By Prof. Carl C. Thomas, Madison, Wis

The operation of this meter depends upon the principle of adding electrically a known quantity of heat to the gas and determining the rate of flow by the rise in temperature of the gas between inlet and outlet of the meter. This principle lends itself to the operation of a meter possessing the following characteristics:

a. There are no moving parts inside the meter or in contact with the gas.

b. The accuracy of the meter and its sensitiveness are independent of the rate of flow of the gas, and of fluctuations in pressure and temperature.

c. The meter may be used to measure gas at high pressure as well as at low pressure, and is independent of small fluctuations in pressure, such as those in the discharge from an air compressor or in the suction of a gas engine.

d. The meter produces a continuous autographic record showing the rate of flow and its variations.

e. Meters of comparatively very small size have very large capacity.

f. The meter may be opened for inspection, for blowing out accumulated matter with an air blast, or for washing with gasolene, and it can be dismantled to any extent desired without interfering with the operation of the plant.

Fig. 1 shows the meter as constructed for air or gas measurement. It consists essentially of two parts: first, the measuring element *A*, Figs. 1, 2 and 3, through which all the gas passes when the meter is in operation; and second, a by-pass, *B*, Fig. 1, so arranged that the meter can be readily cut off from the gas main by operation of the valves *C*, when it is desired to operate without the meter for the purpose of inspecting or cleaning out, or to cut the meter out altogether for any reason.

The meter consists of an electric heater, *D*, Figs. 1 and 3, formed of suitable resistance material disposed across the gas passage in such a way as to impart heat uniformly and at a regular rate to the gas passing through the meter. The temperature of the gas is thus

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*Condensed from Transactions of the American Society of Mechanical Engineers.

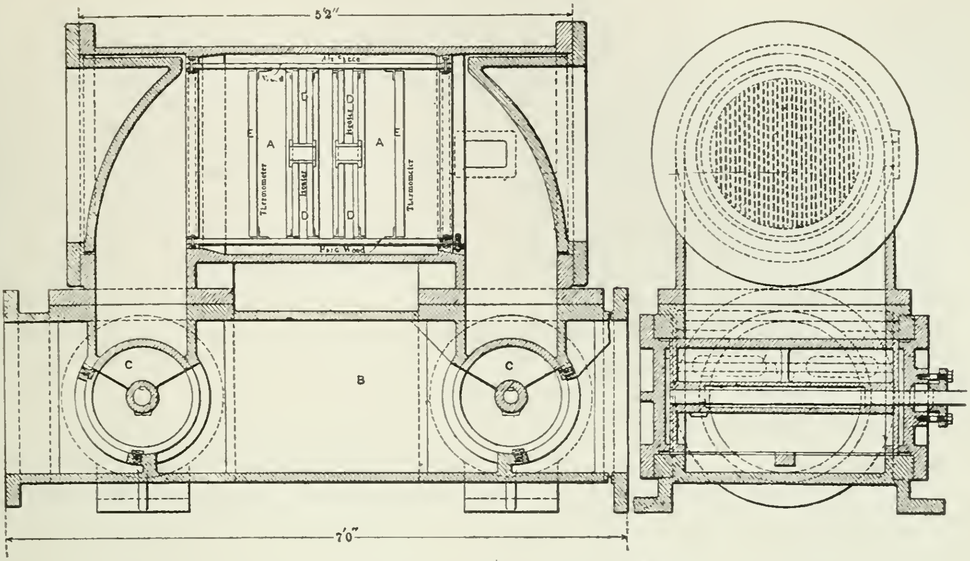

FIG. 1. SECTIONS OF ELECTRIC, GAS OR AIR METER.

raised from that at entrance to some higher exit temperature, and the rise of temperature is measured and autographically recorded by means of the two electrical resistance thermometers *E*; Figs. 1 and 3, on the two sides of the heater.

These thermometers consist of wire wound upon vertical tubes so disposed as to come in contact with all the gas passing through the meter, thereby indicating the average temperature over the cross section of the gas passage. The fifteen tubes shown at the right of Fig. 1. and also shown in Fig. 3 and Fig. 4, extending in a vertical direction over the cross-section of the meter, support the resistance wire of the thermometers so as to afford a rugged construction. These thermometers are connected to a recorder (Fig. 4), which draws a line on a chart and thus indicates the difference of temperature between the two thermometers.

5. A typical diagram is shown in Fig. 5. This diagram represents a gas flow of from 90,000 to 85,000 cu. ft. per hr., taken during a portion of the day when the fluctuation in flow is small, but nevertheless continuous.

The diagram in Fig. 6 was made during a period in which the flow varied extensively, the smallest amount recorded being about 17,000 cu. ft. per hr., increasing to 45,000, then to 62,000, to 75,000, the record ending at a flow of about 32 000.

The record in Fig. 5 was made with a temperature difference of about 4 deg. Fahr. between the two thermometers, and an energy input of approximately 2 kw. The energy input when the record in Fig. 6 was made was approximately 1.15 kw. Fig. 5 is a typical record for a meter of normal capacity of 100,-

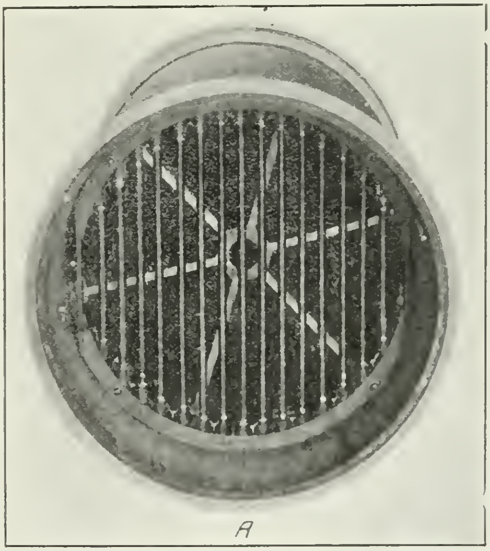

FIG. 1. HEATER UNIT AND RESISTANCE THERMOMETER.

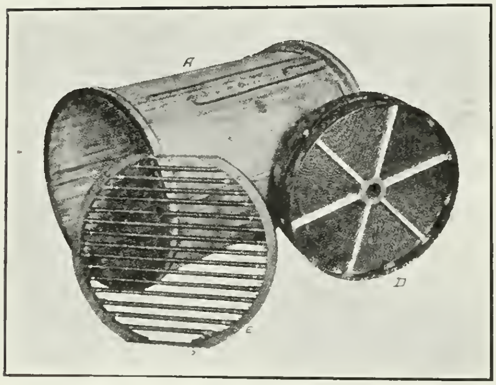

FIG. 3. SHOWING CONSTRUCTION DETAILS.

000 cu. ft. per hr., with an electric input of 2 kw.

The principle underlying the measurement of gas by this means is as follows: If gas is flowing through the heater at a given uniform and constant rate, and if heat is being supplied electrically, and imparted to the gas at a constant rate, a certain definite rise of temperature will be produced in the gas during its passage between the two thermometers and through the heater, and this constant difference of temperature will be maintained so long as the amount of gas passing per unit of time is constant. But if the quantity of gas passing per unit of time diminishes, the heat supplied at the same constant rate as before will raise the temperature of the gas by a greater amount than was the case when a larger quantity of gas was flowing and absorbing the energy liberated by the heater. Conversely, if the rate of flow increases, the energy being supplied to the heater and delivered to the gas will not be able to raise the temperature by as great an amount as when the rate of flow was less. The temperature difference produced by a known input of electrical energy thus forms a measure of the quantity of gas flowing through the meter.

The meters have been calibrated with illuminating gas and with air. A certain amount of water vapor is carried with the gas or air passing the meter. This vapor forms part of the gas or air, and is heated just as are the other constituents. The rise of temperature caused by the heat added in the meter is only a few degrees, and consequently the water vapor does not experience a change of state. The temperature of the metal forming the electric heater rises only 15 or 20 deg. fahr. above the temperature of the gas. The question of latent heat of vaporization of the water vapor therefore does not enter into the considerations underlying measurement of the gas.

While calibration of the meters under actual conditions of service is depended upon to obtain quantitative results, yet these meters are of such a nature that the quantity of gas or air passing through them can be very closely calculated from a knowledge of the energy input and the specific heat of gas or air. This fact, that the quantity of flow can be quite

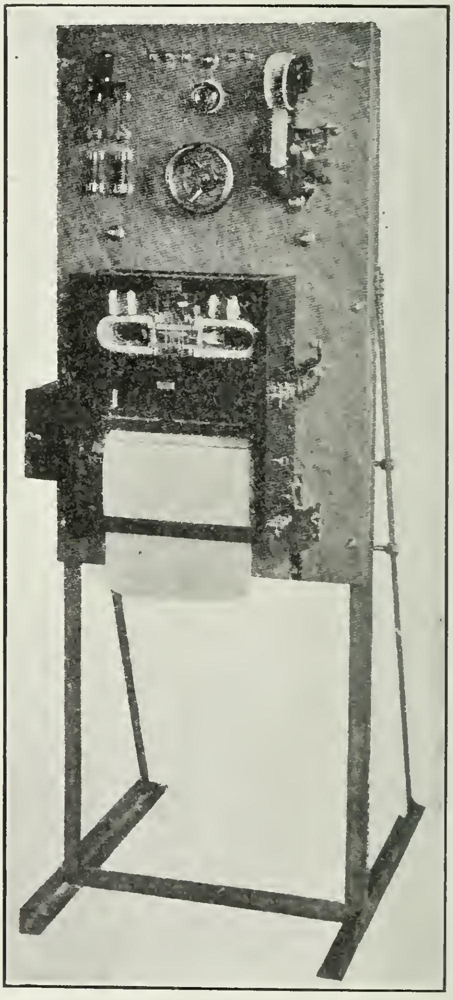

FIG. 4. RECORDING AND OPERATING INSTRUMENT.

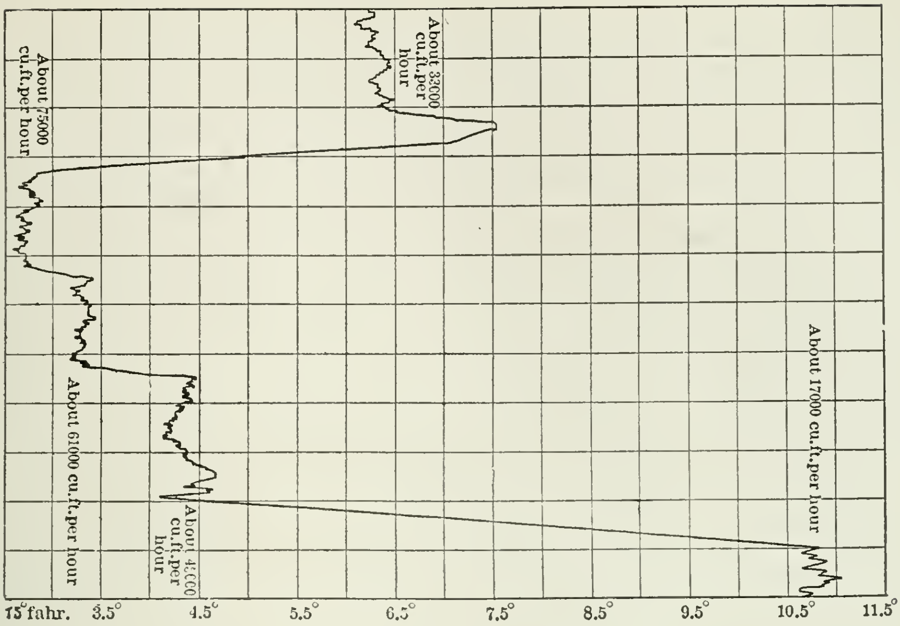

FIG. 6. AUTOGRAPH RECORD.

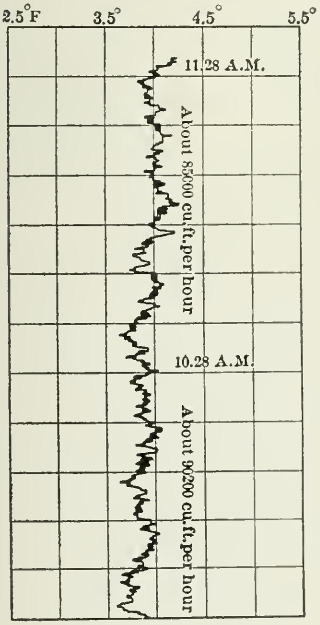

FIG. 5 TYPICAL DIAGRAM.

closely calculated, independently of a calibration curve, makes it possible to check the accuracy of the readings obtained.

The development of this meter is a result of experiments which the writer has been making for some years to determine the specific heat of gases by heating them electrically. The performance of a properly constructed heater for this purpose proved to be so entirely regular that it was apparent that the quantity of gas flowing through it could be very accurately measured by the method now used in these meters. The problem is thus the reverse of the problem of determining specific heat by measurement of the electrical energy necessary to heat the gas. It will be seen by reference to Fig. 1 that the whole process of heating the gas and of measuring the difference of temperature between inlet and outlet, is accomplished in a relatively small space which is well insulated so far as heat losses are concerned, since the heater and thermometers are contained in a casing made of hardwood strips and separated from the metallic walls of the meter by an air space.

The accuracy of these meters is not affected by changes in pressure of the gas or air, since the unit of measurement is that of weight rather than of volume; that is, the meter takes cognizance of the specific gravity, or the amount of "stuff" in a given volume of the gas.

Also variation of temperature of the incoming gas does not affect the accuracy, because it is a difference of temperature, rather than a fixed temperature, upon which the measurement depends. The meter can be used for gas or air at either high or low pressure, and at either high or low temperature, provided the materials used in construction are suited to the conditions.

This method of measuring gas seems especially useful in connection with engines operated by gas from producers, blast furnaces, etc., and in measuring the discharge of gas or air from compressors, because the small and rapid periodic fluctuations of pressure, due to the suction of gas engines or to the discharge from compressors, do not interfere with the steady action of the thermometers. The time lag of the latter is sufficient to smooth out the curve of temperature variation, or of watts input, as the case may be, and true average results are thus indicated.

The temperature difference employed when operating with a constant difference, is approximately 5 deg. fahr. When a curve of temperature difference is employed, the temperature rise is from 4 to 5 deg. fahr. when the normal maximum amount of gas is flowing. This difference may be increased to 10 or 12 deg. when the rate of flow is greatly diminished, and at 100 per cent. overload the temperature difference is from 2 to 2½ deg. On the autographic record one inch represents a temperature difference of one degree. The thermometers and recording device are such as to render the records accurate within 1 per cent. The minute fluctuations shown by the curves on Fig. 5 and Fig. 6 are produced by the constantly varying rate of flow in the gas mains. These can be "damped out" to any extent desired. The apparatus with which this record was taken was purposely made sensitive to minute fluctuations.

The electrical energy required to operate the meters is approximately 1 kw. per 50,000 cu. ft. hourly capacity. The curves shown in Fig. 6 represent variations of from 17,000 to 75,000 cu. ft. per hr., and were made with an energy input of approximately 1.15 kw. To provide for more gas and still have the record lie conveniently on the paper, it is only necessary to increase the energy input by manipulation of the rheostat hand-wheel on the switchboard.

USE AND ABUSE OF MINE VENTILATION*

Probably the oldest book on mining is by Agricola, in which there is a cut showing a man at the top of a shaft using a pair of bellows to send air to the men in the pit. As mines became deeper fire-damp was encountered, and then two openings were made into the mine in order to take advantage of natural ventilation. This is based on a column of cool, heavy air sinking down a mine-shaft, thereby forcing up another shaft a lighter body of heated air from inside the mine. This system of ventilation answered until the mines became so extensive that sufficient air could not be circulated to dilute the noxious or inflammable gases given off in the mines.

At first wooden chimneys were built over the up-cast to furnish a longer column of heated air, but such make-shifts could only afford temporary relief and were succeeded by fire-baskets placed near the bottom of the up-cast. These were a great aid until the extension of the mine caused a drag which was beyond their capacity to cope with. When this occurred furnaces were constructed in the mine, which used the up-cast as a chimney. Furnaces could be made sufficiently large to cope with almost any desired quantity of air, but they were considered dangerous in more ways than one. It is doubtful if one ever set the gas in a mine on fire, although they may have caused a fire in the shaft, or set the coal in the mine on fire through faulty construction.

To overcome the disadvantages of the furnace, attention was turned to mechanical ventilators. Either Bryams or Stranves devised a mammoth pump which had a piston and moved back and forth. This clumsy affair was not generally adopted, but Scheet's and Guibal fans came into use almost universally. The Guibal fan, on account of its sliding shutter and waste chimney, was the more favored, and is used largely to-day. Since then several other fans, including the Cappell and Sorroco, have been introduced.

The object of mine ventilation is to furnish fresh air to dilute the mine gases given off by the coal, men, mules, lights and oxidation. If a mine gives off fire-damp, the rule is to furnish 50 cubic feet of air per minute for every ton of coal mined in twenty-four hours; and 150 cubic feet of air per minute should be supplied for every man. in the mine, irrespective of animals. Roughly, this would require 300,000 cubic feet per minute for 800 men producing 3,200 tons of coal daily, or 375 cubic feet per man per minute. This tonnage and number of men is unusual inside one mine, and while the quantity of air does no harm in an anthracite mine, it may spell disaster in a bituminous mine.

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*From an address by Eugene B. Wilson before the Scranton Y. M. C. A. Mining Institute.

Gaseous mines must have large airways, for the reason that a larger volume of air can be passed with less speed through large than through small airways. If one imagines that all of the air is not passing through the mine, but through an orifice in a thin plate, then the equivalent orifice for any mine would be the aperture in that plate of an area such that a resistance would be offered to the air equal in amount to that caused by the mine workings.

Even with large areas to the airways, the air must be split and directed to the various workings in order that:

1—Each split will receive its quota of air.

2—The air may be regulated to supply the requirements of the men and the workings.

3—The friction of the air current may be reduced.

4—That the fresh air need not travel from one working to another, and so become impure before it reaches those in the last workings through which it travels.

It makes considerable difference whether the air is split properly—that is, properly distributed. There must be no short-circuiting. Air stoppings, overcasts, regulators and doors must be properly proportioned and kept in perfect repair. When it is necessary to drive ahead of the air the brattice or air boxes must be properly arranged, and under such conditions it is possible to work in safety in most mines.

Where sufficient gas occurs to call a mine gaseous more safety precautions are adopted and only safety lamps are used. If open lamps are permitted at all, it is only a question of time when they will pass into the danger zone and cause trouble. In such mines too much dependence is placed on the ventilation, which, up to the time of the accident, has proved sufficient to dilute all gas.

Ordinarily, one cannot have too much air, but it would seem that in coal mines such a matter is possible. In order to make this statement clear let us review three fatal explosions that have occurred in this valley in the last three months.

It frequently happens in anthracite mining that more gas will be given off from a face at one time than at another. There is no telling when this will occur, as it may come from a blast, a drill-hole, a fall of rock, or other cause. This increased flow of gas may cause a slight explosion, which, being local, is not considered more than an every-day occurrence. In one such case there was a local explosion, which seemed to have been slight in its effects. The men working in their rooms were not disturbed by it, but were told to leave.

Instead of doing so at once, they leisurely gathered up their coats, buckets and tools, and reached the gangway just in time to walk into the after-damp. This was where too much dependence was placed on the ventilation; but it teaches the lesson that where one is in the return air-course the only sure way to safety is to get out of it, whether the explosion is violent or insignificant.

It takes only a short time for one per cent. of carbon monoxide to kill a person; and there is almost sure to be that much in the after-damp of any explosion. There should not be any dependence placed on an air-current after an explosion, because the quantity of after-damp cannot be measured, and because the explosion may have disarranged the otherwise good circulation.

Not a long time after the above explosion another occurred, with fatal results. In this case a door was broken in such a manner as to allow a large part of the air that was intended to be sent up the heading to short-circuit. The working place was known to contain gas, but the men continued at work for over a day after the door was broken. Gradually the gas accumulated until it reached the explosive stage, and then several men lost their lives. Here again too much dependence was placed on the air; or, it might be said that the ventilation was abused.

The lesson to be drawn in this case is summed up in the phrase: "Nothing should be taken for granted where gas is given off." With a good ventilating current and plenty of air properly directed we can only imagine a person to be over-confident who will work in the place where this accident occurred.

Only a few weeks ago another accident occurred where several capable miners lost their lives through some defect in the ventilating current or a sudden increase of gas. In this particular case the men were warned against using open lights, but after the accident they were found dead with safety-lamps in their pockets. Everything in this case would have gone all right if something had not gone wrong; and, since it is always the unexpected that happens, no chances whatever should be taken any more with gas in a mine than with powder.

When men will run risks with open lights it becomes a case of either too much ventilation or an abuse of ventilation. If there had been no use for safety lamps in the mines in which these accidents occured there might be some extenuating circumstances; but safety-lamps were required in some part of each mine. Had all been required to use safety-lamps the men would have run from the after-damp in the first explosion, they would have fixed the door in the second explosion, and they would not have used open lamps in the third explosion.

The men who lost their lives have not been accused of negligence, which means inattention to their duties or carelessness in the performance of their duties, because it is not clear that any of them were. It seems that they placed too much dependence on the ventilating current, which theretofore had answered all requirements; but there was too much ventilation, or the men would not have depended so implicitly upon it. Again, it is possible that the current was all right, but was abused in some manner so that it could not perform its functions properly, though not through any fault of the deceased.

It is not satisfactory to say that the deceased were negligent, but it is fair to say there was too much air or the ventilating current was abused. If the current had not been abused there would have been no after-damp in the first case; the door would have been repaired in the second place; and there would have been no accident in the last case, which is blamed to an open door.

This method of reasoning some of you will consider equal to that adopted for perpetual motion, where

Man eats fish,
Fish eat worms,
Worms eat man.

Is it not so?

There is more gas in the anthracite than in the bituminous coal mines, for which you men may be thankful. If the bituminous mines contained the same quantity of gas as the anthracite mines they would blow up weekly.

All rocks have pores, and contain quarry water. This works to the surface exposed to the ventilating current, and, under those conditions, where the mine air can absorb moisture, it will absorb it from the coal. This causes the coal to slack and offer surfaces for the air to abstract more water, and oxide as well. After the coal has become impalpable dust it is in an excellent condition to ignite, and when, from any reason, it does so, then a dust explosion occurs.

ENORMOUS FIRE LOSSES IN THE UNITED STATES

In a paper by Mr. Frank B. Gilbreth, presented at the October meeting in New York of the American Society of Mechanical Engineers, it was stated that the total cost of fires in the United States in 1907 amounted to almost half the cost of the new buildings constructed in the country for the year. The total fire loss, including that of forest fires and marine losses, amounted to over $456,485,000. In addition to this waste of wealth and natural resources, 1,449 persons were killed and 5,654 were injured in fires. The buildings consumed, if placed on lots of 65 ft. frontage, would line both sides of a street extending from New York to Chicago. A person journeying along this street of desolation would pass in every thousand feet a ruin from which an injured person was taken. At every three-quarters of a mile in this journey he would encounter the charred remains of a human being who had been burned to death. The results obtained indicate that the total annual cost of fires in the United States, if buildings were as nearly fireproof as in Europe, would be $90,000,000, and that therefore the United States is paying annually a preventable tax of more than $366,000,000, or nearly enough to build a Panama Canal each year.

AMONG THE DRAWBACKS OF CIVILIZATION

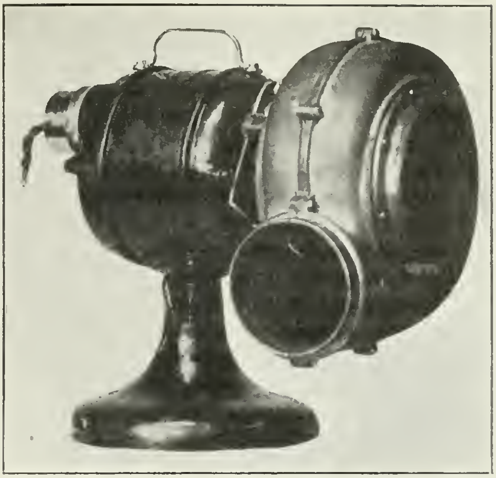
The following must be shouldered by the *British Medical Journal*:

In humanitarian circles it is customary to speak of civilization as a disease and to compare the noble savage and the effete citizen in a manner greatly to the latter's disadvantage from the point of view of health and constitution. Facts do not lend unqualified support to this kind of idealism, yet it must be confessed that the list of industrial diseases, already formidable, is a constantly growing one and that every new invention carries attendant evils in its train.

Among distinctively modern diseases may be instanced the poisoning produced by the fumes of calcium carbide or acetylene; the headache, dyspepsia, cardiac failure, and sensory disturbances traceable to the manufacture and use of aniline dyes; the frothing of the blood, known as caisson disease, which follows too rapid decompression in workers on the foundations of bridges; the functional neurosis known as telegraphists' cramp, resulting from the use of the Morse key, and the numerous affections of the skin, lungs, digestive tract and eyes due to irrattation by organic or inorganic dusts of industrial origin.

Among the last named special mention may be made of "shoddy fever," caused by the dust rising from pulverization of wool-containing rags. A modern danger par excellence is that of electrocution by contact with live wires, to which innumerable workers are daily and hourly exposed. Direct currents of 700 volts pressure and upward and alternating currents of half that amount are officially recognized as dangerous to life, but even lower charges have produced fatal results.

With the sad cases of Dr. Hall-Edwards and Dr. Kassabian fresh in their minds, medical readers do not need reminding of the terrible potentialities of the Roentgen ray. The conquest of the air is proving so costly to life that there is a growing feeling that its commercial exploitation by health and pleasure resorts in the form of "flying weeks" has been altogether premature, and should for the present be stopped. If therefore we cannot admit that civilization is itself in essence pathological, neither can we deny the costliness of its benefits or the pathogenetic associations of its every forward step.



WESTINGHOUSE GENERAL UTILITY MOTOR

The half tone shows one of the many applications of a general utility electric motor now being placed on the market by the Westinghouse Electric and Manufacturing Company. Its most evident line of employment is in domestic service, wherein by means of special attachments it can be applied to a variety of uses, and in light manufacturing its adaptability is unlimited. It can drive a ventilating blower as here shown, the family sewing machine, buffing, polishing and grinding wheels, jewelers' lathes, light machinery of all kinds, sign flashers, moving window displays, mechanical toys, etc. The small blower will supply fresh air to the kitchen, increase the draft of a furnace, remove foul air from sick rooms, and readily adapt itself to any small ventilating work.

The motor is light and has a handle by which it may be carried from place to place. It takes from 40 to 120 watts for its operation, running at 1700 r. p. m. It is made for operation on 115 or 230 volt direct current circuits, or on 110 and 220 volt alternating circuits of 60 or 133 cycles. The direct current motors are shunt wound while the alternating current motors are of the induction type, single phase. The motor is artistically finished in black enamel so that it would not look out of place anywhere.

Mountains of pure marble have been discovered in German South Africa, the like of which are unknown in the world.

ASBESTOS

The mystery of the mineral kingdom is asbestos. Many scientists look upon it as a sort of link between the mineral and the vegetable world. It might be said to resemble a mineralogical vegetable, possessing the curious properties found in both; for it is at once fibrous and crystalline, elastic and brittle, heavy as a rock when taken from the mines, but light as spun silk when treated mechanically. Soft, delicate almost as cobweb, the fibres of this strange mineral are so nearly indestructible that they have withstood the action of the elements since the world began. Through all the countless ages, during which the hardest rocks surrounding it have changed their characters, this geological freak has remained intact, having successfully resisted the assaults of fire, acids, and time. Historians are pretty well agreed that the strange mineral was known thousands of years prior to the Christian era, being prized by the ancients more as an article of extreme luxury or as a wonderful and interesting curiosity than as something of practical utility. The Egyptians of the earlier Pharaoh dynasties, engaged as they were in commerce with the Athenians, built up a considerable industry in the manufacture of what were known as "cere cloths," garments in which the mummified dead were wrapped for preservation. There is a specimen of asbestos textile in the museum of the Vatican library which was unearthed in Rome in the eighteenth century.

No evidence of this industry appears in modern writings until the early seventies of the nineteenth century, when experiments for using it commercially were made in Switzerland. Shortly after this the first specimens of a very fine, white asbestos, mined in Canada, were exhibited in London. They attracted little serious attention at the time, however, and it was not until 1878 that Canadian asbestos began to be mined on a large scale. Since then the Black Lake region of Quebec has been found to produce the finest fibre in the world, and now nearly 90 per cent. of all the asbestos used comes from the Dominion. Deposits are found, however, all over the world, notably in South Africa, but none of them produce the white fibre of the Canadian mines, their color ranging from blue and green to the recently discovered and very beautiful pink asbestos of India. The spinning and weaving of asbestos has offered many difficulties, as the asbestos fibres have no rough surface like wool or cotton, but are very smooth and thus have a tendency to slip by one another when twisted and subject to tension. An admixture of vegetable or animal fibre was therefore often necessary, but while these facilitated the manufacturing operations, they impaired the fire resistance of the fabric, and special machinery and ingenious devices had to be invented to enable the successful spinning of a pure asbestos yarn; it is, however, now possible to make a single asbestos thread a mile in length which weighs but a pound and a half.

RUST REVELATION IN THE DEMOLITION ON AN OFFICE BUILDING*

The Gillender Building, a seventeen story structure at the northwest corner of Wall and Nassau streets, New York City, was built in 1896 and removed in 1910. [See COMPRESSED AIR MAGAZINE, July, 1910.]

When built, all the columns were encased in solid brickwork. The steelwork received one coat of paint in the shop and two after erection, but on removal, showed little evidence of ever having been painted at all. From the top to the bottom, wherever the spaces between the brick and steel were filled with Portland cement mortar, there was no rusting, but, wherever the mortar did not fill such spaces completely, rusting had begun. Generally, the under sides of the top and bottom flanges of the floor-beams had begun to show rust, while the web and upper surfaces, having been in contact with mortar, were in good condition.

The worst rusting of all was from the sixth floor down, on the northeast corner, where the columns had been against the adjoining building, on the north side. The cover-plates of these columns looked as if they had never been painted, but had stood in the open, exposed to all weather, for six or seven years. On these columns one-half, in volume, of many rivet heads could easily be removed.

This building had been erected by first-class contractors and with first-class materials; and although the rusting had not yet made the building unsafe, there is no telling how soon it would have become so. It would seem that if the columns had been encased and filled with wet concrete there would have been little danger of rust, and they could thus have been easily protected from electrolysis. Oil or oil paints should not be placed on steel to be thus encased.

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*A paper by T. Kennard Thomson. Proceedings American Society of Civil Engineers.

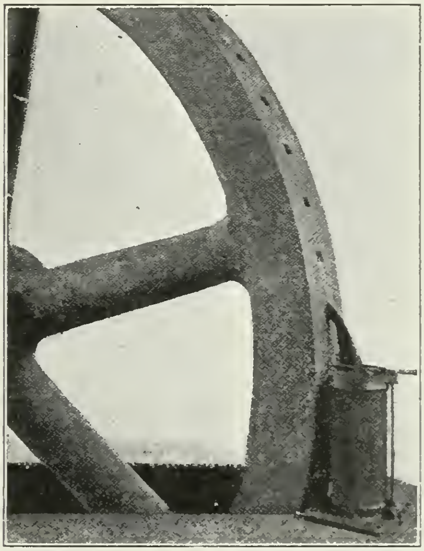
Messrs. Trowbridge and Livingston are the architects for the 39-story Bankers' Trust Building which will take the place of the Gillender Building, and Messrs. Marc Eidlitz & Son are the contractors, to whom the writer gives his thanks.

POSSIBLE REFINEMENTS IN STEAM PRACTICE

There may be steam-jacketed cylinders with infinitesimal clearances, and valves and pistons as tight as the proverbial bottle. Contraflo condensers equipped with air pumps of miraculous efficiency may produce vacuums rivaling the comet's tail in tenuity. There may be boilers and economizers so correctly proportioned that the escape of a single heat unit is almost as improbable as the discovery of an honest professional politician. There may be water-weighing apparatus so accurately adjusted that it could on a pinch be used for a barometer, and the walls may be decorated with flue-gas analyzing apparatus that resembles a chemical laboratory in its complicated completeness. There may be continuous and intermittent steam-engine indicators, recording thermometers and pressure gages. Superheaters may furnish steam so dry that its own weight of water will scarcely moisten it, and besides there may be a chief engineer worth a congressman's salary. *Ad. page of Power and the Engineer.*

SOUTH AMERICAN RAILWAY ALTITUDES

The Antofagasta & Bolivia Ry. Co. can claim the distinction of having the highest railway in the world. This railway has a 2-ft. 6-in. gage. Over this route the company runs sleeping and day coaches from Antofagasta on the Chilian coast to Oruro, 574 miles distant. From Antofagasta the line gradually rises to an altitude of 13,000 ft., which is reached at Ascotan, 223 miles from Antofagasta, and the main line runs for many miles at an almost uniform level of 12,000 ft. above the sea. The claim in respect of being the highest line of railway in the world is made not for the Antofagasta main line, but for the branch line which runs from Ollague to Collahuasi, on which the rails are laid at the great height of 15,809 ft. above sea level. Moreover, even this great altitude will, it is stated, be exceeded on the branch lines now being constructed by the Antofagasta Co. from Rio Mulato to Potosi. This is a line of a meter gage, and it is believed that the rails will reach a height exceeding 16,000 ft. At the present time the distinction of possessing the second highest railway in the world may be claimed for the Oroya Railway in Peru, where the line attains an altitude of 15,583 ft. The third highest line of rails is on the Peruvian Southern system, where a height of 14.665 ft. is reached at Portez del Cruzera. The greatest height prevailing on the Argentine and Chilian Transandine Ry. is 10,466 ft.



THE BADGER PNEUMATIC ENGINE JACK

The little halftone seems to tell all there is to be told about the Pneumatic Jack built by the Wisconsin Engine Company, Corliss, Wis., for helping an engine or an air compressor over the center. On large engines, and particularly on engines getting hard service, and quite generally on heavy air compressors, the jack should be a saver of time and labor. It may be fastened down in proper position and permanently piped or it may be moved around from one wheel to another and connected with a small hose. The pawl swings back out of the way as soon as the wheel starts.

OLD MEASURES RETAINED IN ENGLAND

It is not generally realized in the United States to what extent the old units are still retained in use in Great Britain. It is pretty well known that the U. S. gallon differs slightly from the imperial gallon; but the following from the London *Times* of Sept. 10, indicates that other gallons still persist in England.

"At a recent meeting of the Central Association of Dairy Farmers recommendations were agreed upon as to the London prices for Michaelmas contracts for the supply of milk. The prices were as follows: For short-distance railway transit milk 10d. and 8d. per imperial gallon, and for long-distance railway transit milk 9½d. and 7½d. per imperial gallon. These prices represent respectively 1s. 9d. and 1s. 5d. and 1s. 8d. and 1s. 4d. per barn gallon."

From the above it would appear that the "barn gallon" is a trifle more than double the imperial gallon. The only conjecture possible is that the "barn gallon" of milk must be a peck measure full.

In measures of weight, while in the United States all units except the pound and ton have become obsolete, except of course in the drug and jewelry trades, and the short ton of 2,000 lbs. has driven out the "long" ton of 2,240 lbs., except in the coal and ore trade, the English still cling to the "hundred weight" which is not a hundred pounds but 1/20 of a "long" ton, the only ton in England, and also to the "quarter" and "stone." Penny-in-the-slot weighing machines in England always show a person's weight in "stones."

Market customs are even more confusing to the uninitiated than the varying weight units. The following are the units in which current quotations are made of principal products on the London market: Barley, per 400 lbs.; Maize, per 480 lbs.; Oats, English, per 312 lbs.; Oats, Russian, per 304 lbs.; Rice, per cwt. Wheat, English, per 480 lbs.; Manitoba, per 496 lbs.; October in Liverpool, per 100 lbs.; September in Chicago, per bushel. Hay, per load. Linseed, California, per 410 lbs.; La Plata, per 416 lbs.

The same paper containing the above quotations advertises many parcels of land for sale with the area given in acres, roods and perches. We may also note that the furlong still survives in the English race courses.

OZONE IN FRANCE

Writing from Nice, France, U. S. Consul Hunter gives a brief description of the ozone water sterilization plant used for purifying the public supply of that city. Two plants were built in 1909, one with a capacity of about 3,400,000 gallons a day and the other with double that. Each of these is composed of two systems in duplicate to insure continuous action. He reports that a new plant is under construction which will have sufficient capacity to supply all the towns and cities between Nice and Mentone, a distance of 24 miles.

The water to be sterilized operates turbines used for generating the necessary electric current. This is produced at 110 volts, which is transformed into an alternating current of 17,000 volts, at which potential it is used. There are five so-called batteries, each consisting of three vertical copper plates two feet square and 1½ inches thick, with a space of 8 inches between them; in each of which spaces is a pair of glass sheets, between which the electric discharge takes place and the air is drawn by a suction machine. The ozonized air is passed through a vertical vitrified pipe containing charcoal dust and pieces of cement. To bring the water and ozone in contact, the former, under a head of 12 feet, is sprayed through openings in 1-inch pipes into a chamber filled with the ozonized air. The water then flows through 3 feet of pebbles from which it drops like rain to the bottom of a tank, passing, in so doing, through a strong current of ozone, a part of which is absorbed by it.

ELECTRIC SHOCK

At the recent meeting of the British Medical Association Dr. S. Jellinek, of Vienna, read a paper on "Disorders and Death Following Electric Shock." He stated that, while in some cases fatal accidents had been brought about by shocks at 100 volts, in other cases, in which the voltage had been 1,000, and even 10,000, recovery had ensued. In order to understand a matter so seemingly inconsistent, the doctor stated, it should be kept in mind that the danger of an electric current depended on circumstances which might be placed in the following two categories: 1. The external: (a) voltage, (b) amperage, (c) number of poles, (d) the time limit of contact, and (e) the kind of current (a.c. or d.c.). The continuous current appeared to be more dangerous than the alternating. 2. The individual: (a) the resistance of skin and body, (b) the path of the current through the body, or over the surface of the skin, and (c) the condition of mind and body. The speaker stated that electric lesions were painless. With regard to the mechanism of death by electricity there was no definite scheme or model. In most cases it seemed like suspended animation. It was an interesting fact that there was between electric shock and death an interim of a few seconds in which the stricken person appeared to be quite in normal state. By experiments on dogs in the physiological institute of Prof. von Tschermak it had been discovered that the irritability of the brain, which had subsided immediately after a shock, had a few seconds later become re-established, and everything then depended upon whether the action of the heart would be continued or not. As there were sometimes haemorrhages in the brain, and as the pressure of the cerebrospinal liquid was increased, it was necessary and important in cases of first aid to lay the patient with the head elevated.

TUNNEL VENTILATION

The three items following rather curiously come to hand on the same day:

Hollister, Cal., Aug. 29.—Asphyxiated by noxious gases within 200 feet of the mouth of the San Carlos tunnel in the New Idra quicksilver mine, was the fate on Sunday night of Foreman John Williams, his three daughters, Elvina, aged 15 years; Marie, aged 12, and Marjorie, aged 5, and a dog belonging to the family. The bodies were discovered last night. The tunnel is situated six miles from the mine proper, and is 2,500 feet long. Williams and his daughters were returning from the face of the tunnel and had nearly reached the open air when they were overcome.

Helena, Mont., Aug. 29.—A. E. Marshall, a fireman of the Northern Pacific Railway, was asphyxiated in the Mullan tunnel early this morning. Marshall was fireman on helper engine 3,010, and, with Engineer James Sheppard, was sent out to help train 1,615, extra west, over the Mullan hill. When the train reached the mouth of the tunnel the fireman on the helper, as is the custom, got into the caboose to ride through the tunnel, and according to the information received in Helena, the train broke in the tunnel. It was repaired, but when an attempt was made to start it a drawhead was pulled out of one of the cars. Marshall then left the caboose to go to the aid of the engineer, and it was while so engaged that he was overcome with gas and his life snuffed out. Engineer Sheppard also was overcome, but revived and was able to resume charge of his engine.

Mauch Chunk, Pa., August 31.—Because the ventilation system has proved insufficient at the depth penetrated, work had been suspended at the new drainage tunnel which is being driven by the Lehigh Coal & Navigation Company up the Nesquehoning Valley. The company placed powerful fans at each end of the tunnel, which are kept going day and night for the purpose of supplying the workmen with fresh air. This worked all right until the tunnel was driven one and one-half miles from each end, when the force of the fans was spent before reaching the workmen, who were compelled to quit for want of better air. The company will now have to open vent holes at different places, which, on account of the depth of the tunnel, will require several months, and meanwhile the work of further tunneling is suspended.

LARGEST ELECTRIC MOTOR

The 6,500 horsepower motor for driving the 60 inch universal mill at Gary was recently referred to as the largest motor in the world. A report comes from England, however, of a motor being built by the Siemens Bros. Dynamo Works, Stafford, which completely overshadows the Gary unit. The British motor, however, is designed for direct current and is of little more than half the weight of the American machine. The Siemens motor will develop 10,000 horsepower at 60 revolutions per minute with current at 920 volts. It is so designed that, at a later date, the voltage can be raised to about 1,400 volts, when it will carry peak loads of 15,000 brake-horsepower at 90 revolutions per minute. It will be coupled direct to a 36-inch cogging mill and a finishing mill, and will roll 2½-ton ingots down to rails in one operation without reheating. It is stated that the operator will be able to reverse the motor from full speed in one direction to full speed in the other nearly 30 times per minute.

NOTES

A large piece of opal, weighing about 60 lbs., was recently found at Whitecliffs, Australia, and sold to a German buyer. It was broken in halves while mining, the value being estimated at £2 per oz., or nearly £2,000 in full.

A rust-proofing process for iron and steel, called Coslettising, consists in boiling the articles to be treated in a solution of 1 gallon of water, 4 ounces of phosphoric acid and 1 ounce of iron filings. By this means a black coating is produced on the iron or steel surface which protects it from atmospheric or other corrosive influences.

Another use for aluminum has been found in combining it with gold to produce a metal that is said to possess a beautiful hue adaptable for wide use in the jewelry trade. The alloy is composed of about 78 per cent. gold, and the aluminum seems to give just about enough different colour to give a very artistic appearance.

O. Spencer, a farmer and stock raiser, owner of the famous pacing horse, Gratt, 2.02¼, who resides near Rich Hill, Mo., recently turned a bunch of hogs into the pasture and they immediately began very energetically to root up the sod, exposing shale. With very little effort Mr. Spencer opened a pit of excellent coal, the vein being seven feet thick.

The first of the large caissons for the foundations of the new piers of the Quebec bridge has been launched. The new superstructure will be 30 feet wider than in the previous plan and the new centre line of the bridge has therefore been located 15 feet up stream. The caisson measures 54 by 180 feet and weighs 1700 tons, while the caisson for the south pier 79 by 180 feet, will be the largest of its kind ever built.

Within ten years there has been a growth of copper production throughout the globe of over 90 per cent., and during the same period the United States output from domestic sources also shows an increase of 90 per cent. The United States refinery production from all domestic and foreign sources in 1909, however, was more than double the total production of this country and the American imports ten years ago.

For some time large growers of tomatoes, cucumbers and similar vegetables for the London market have been accustomed to inject steam into the soil with the view of destroying insects and slugs. The plan operates very well for that purpose, but the unexpected fact has developed that the soil thus treated increases greatly in fertility.

In half a century the United States Department of Agriculture has grown from a mere beginning to an institution with over 11,000 employes. Congress supplies it with an annual income for its expenditure in the neighborhood of $15,000,000, while half as much more is spent by the States in their agricultural experiments, colleges and experimental stations. Of its employes, nearly 3,000 are scientists, hundreds are administrative officers, and thousands are clerks and helpers.

The fixation of atmospheric nitrogen has made great strides in Europe during the past few years. It has recently been reported that a company, known as La Nitrogêne, now has a plant in operation at Roche de Rame, Hautes-Alps, for the production of nitric acid from atmospheric nitrogen. In this plant the Pauling process is employed, by which the fixation of the nitrogen is accomplished by means of electric-arc discharges. The electricity is generated by water power. The normal yield of the furnaces is stated to be from 60 to 70 gms. per kilowatt-hour. (0.1 to 0.115 lb. per horse power hour).

The following, suggesting the augmentation of our supply of rubber by the use of banana juice, is taken from a paper printed in British Guiana: "About two years ago, whilst experimenting with some banana juice, so as to find out how best to mordant it; a thick and pliable rubber was found to attach itself to the sides of the enamel dish which held the juice. The rubber was ultimately sent to England and to America, and it was found to be what is known as a synthetic rubber, and when compounded with other rubbers it appeared to have a distinct market value, by increasing both the weight and the value of the rubbers with which it was compounded."

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - Editor
FRANK RICHARDS, - - Managing Editor
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PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.
Those who fail to receive papers promptly will please notify us at once.
Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

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THE NEW TOOL IN THE ENGINEER'S KIT

The skill of the workman is worth but little unless he has a proper kit of tools, and the range and excellence of his work will depend upon their variety and their condition of efficiency. The tools at hand often determine the way of doing a job, and a lack of the right tool often makes a job cost too much. We are all familiar enough with the puttering of the carpenter or the plumber who comes to do some repairing about the house without the proper means for doing it.

The mining and tunneling engineer, the planner and the executor of the larger works in rock excavation and stone construction, has his kit at command just the same as the workman. Although he does not lug his tools on his shoulder or personally handle them at all, still they are under his direction and must do his bidding. In the later years he has welcomed valuable additions to his kit, and these have so transformed his methods and quickened and extended his achievements as to make those of the ancients seem absurd, and even contemptible in comparison.

Prominent in the modern engineer's kit are rock drills and the high explosives. These have vastly cheapened his work, enabling him to accomplish so much and to do things so rapidly that he might be expected soon to be looking for other employment; yet, in accord with the general habit of progress, the work is piling up ahead of him faster than ever, and he is hustling to improve his facilities, especially by concentration and simplification at the power end.

The problem of the drive for the widely distributed machinery employed in mining, in tunneling and in the larger operations having to do with water transmission and improved facilities for navigation, is most urgent. Steam had it all its own way for a long time and claimed, after a fashion, to drive everything. Then came the rock drill insisting that only compressed air was good enough for it, and later we have electricity the most boastful and self-sufficient of all. Electricity has failed to make good, so far as the direct driving of rock drills is concerned, and now, mostly in consequence of that, we have extensive operations in progress where steam, compressed air and electricity each have their own peculiar share of the work, while the desirability of one driver for all is apparent and urgent.

How much better would be the one general means of power transmission than the three, especially when there can in these days be but little question as to what in many cases it should be. Electricity we must have anyway for our lighting, and for all machinery which is essentially rotative it does its work with little loss at either end, or even along the way if it be not excessively long. Where, as often now happens, there are special reasons for the use of electricity as the means of power transmission it can do practically everything except to drive the rock drills.

This disability prevails no longer, having been immediately annihilated by the advent of the electric air drill. While this drill is an air operated machine as completely and entirely as any machine ever designed, it is just as completely, right up to the apparatus itself, an electric driven machine, and it has no source of power other than the wires which connect it to the generator. There are, moreover, no sacrifices or compromises involved in its employment, and nothing apparently but advantages upon its side. No rock drill strikes sharper, more efficient or more continuous blows, and no other drill does its work for so little power consumed. The cost of drill and pulsator is all that has to be considered after the current is provided.

The most remote and diverse conditions suggest the special adaptability of the electric-air drill. It can be placed and operated at its best in locations inaccessible to any other drill. Some of our most valuable mineral deposits are in the most out of the way places, but the drill may be transported wherever men can climb, and a wire is all that is required to actuate it. In excavating for building foundations in our cities nothing could be so handy, as current is always on tap.

RADIALAX POSSIBILITIES

The Radialax, being mostly used underground in mining or tunnel driving, is normally an air driven machine. The Radialax principle would seem to be generally and widely applicable to operations in stone excavation, the working in fixed planes being dictated not only by the natural cleavage of the rock, but also by the planes which usually are required by the shapes of the finished blocks for building, monumental or other uses. As generally happens in the development of inventions, what is most obvious in the retrospect is delayed in its first inception until the less serviceable devices, each an improvement upon its predecessor, have been successively worked out and their deficiencies, as well as their possibilities, revealed. The Radialax is comparatively a newcomer; we may easily believe that all the possibilities for its employment and the advantages of it have not yet all been developed, and we may expect its more extensive employment in the future.

The Radialax comes along naturally as the successor and working companion of the stone channeler. The latter may be said to work normally with vertical bits or cutters, the cut being in a vertical plane, permitting liberal angular departures from the vertical in either direction of working, while the normal working of the Radialax would, perhaps, be difficult to determine. When cutting in a vertical plane its movement would be horizontal when working in its central position, but from this normal or central direction it would change constantly in both directions as it made the sweep of the cut. When working in the horizontal plane while its working movement would be constantly horizontal the lateral direction would be constantly changing. From either the vertical or the horizontal plane of working the Radialax operates with equal facility at any required angular pitch in either direction.

It not only carries cutters whose function is the same as that of the stone channeler, but it also works as a regular rock drill, putting in holes in any direction and to any required depth for blasting. It is quickly and easily adjusted for working in any direction and for either channeling or drilling, and the parts of the apparatus are easily separated into convenient weights for handling.

The special characteristics of the Radialax peculiarity qualify it for the variety of operations involved in the work of the coal mine, although the principal operation is a species of rough channeling in directions paralleling the strata, which seldom vary far from the horizontal. This horizontal working will consist of undercutting the seam so that the coal can be easily broken down, the most persistent operation of coal getting, or of cutting out of bands of clay, which often occur in the middle of a seam and seriously impair the purity of the coal if not removed. Especially in this latter case some precision of location is required, with the greatest facility of movement, so that time will not be wasted; and in this the Radialax would seem to have it practically all to itself.

For the vertical channeling, if we may so call it, which occurs in coal getting, for entry driving, for shearing on either side in the rooms, or for center cutting, so that light shots will bring down the coal in large lumps and with the least shattering of the walls, the Radialax again approaches the ideal.

Each coal mine is different in some respects from every other, and the work of getting out the coal as cheaply and in as good condition as possible will vary in essential particulars. The most desirable characteristic of a machine for which a market may be expected must be adaptability, a readiness to work in all positions, in widely varying conditions, and to turn itself from one style of cutting to the other, as required, and for this the Radialax is eminently adapted.

In the work of driving subway tunnels in the large cities through solid rock under or close to the foundations of large and costly buildings, where it is imperative that the shock of the blasting shall not damage or even endanger the surroundings, central vertical cuts made in the headings previous to the blasting at the sides give spaces toward which the rock may break without destructive reactionary effects. There would seem to be many cases where this employment of the radialax, or its equivalent when found, should be officially enforced.

LOSS OF OXYGEN IN HYDRAULIC COMPRESSION OF AIR

In our September issue attention was called to the fact that the air delivered by the hydraulic compressing plant at Ragged Chutes, Cobalt District, Ontario, has considerably less than its due proportion of oxygen, analysis showing 17.7 per cent. instead of the normal 21 per cent. The following letter of Prof. Olin H. Landreth, Dean of Engineering, Union College, Schenectady, N. Y., offers a clear and convincing explanation of the effect observed and suggests that it must be a necessary accompaniment of the process. Prof. Landreth says:

The loss of oxygen in hydraulic air compression, mentioned in connection with the compressed air supplied to Cobalt mines, is due to the well known fact that water will absorb different amounts of different gases, just as it dissolves different weights of different soluble materials.

ABSORPTION OF OXYGEN AND NITROGEN IN WATER.

For oxygen and nitrogen, the accompanying table gives the approximate percentage by volume absorbed to the absorbing water. This is stated for normal pressure, or one atmosphere; for other pressures the weights of oxygen absorbed increase in approximately direct proportion to the pressure, but as the density also increases as the pressure, the volumes (as measured under the varying pressure) are about constant.

PERCENTAGE OF GASES ABSORBED TO VOLUME OF ABSORBING WATER—PRESSURE, ONE ATMOSPHERE.

Temperature, Deg. C.	Ogygen, Per Cent.*	Nitrogen, Per Cent.
0	1.027	1.856
5	0.891	1.630
10	0.787	1.450
15	0.704	1.307
20	0.635	1.191
25	0.575	1.096

*These are true percentages; ratios are 1-100 of the above percentages.

The figures given in the absorption table are for atmospheric oxygen and nitrogen, not single, separate gases. They therefore represent conditions just as one would find them in hydraulic compression. The table shows that water absorbs from 80 to 90 per cent. more nitrogen from the atmosphere than of oxygen.

OXYGEN ABSORBED MORE READILY THAN NITROGEN

If, however, these tabular percentages be divided by 0.21 for the oxygen and by 0.79 for the nitrogen, being the proportions of each gas in one cubic foot of air, it is seen that for the same volume of gas offered for absorption, oxygen is absorbed more than twice as fast as nitrogen, and the composition of the air taken up by the water is richer in oxygen than the original air. As the absorbed air is mostly carried away by the water flowing from the uptake shaft, the air which remains and which is used for industrial purposes is poorer in oxygen than the original air. The absorbed air is largely given up from the water, but only after the water has risen in the uptake till the pressure is reduced, and even then is largely held in minute globules which give the water a milky appearance.

PER CENT. OF GAS CONTAINED IN A GIVEN VOLUME OF AIR ABSORBED BY THAT VOLUME OF WATER.

Temperature, Deg. C.	Oxygen. Per Cent.	Nitrogen, Per Cent.	Ratio. O:N.
0	4.89	2.35	2.08
5	4.24	2.07	2.05

NEW BOOK

Compressed Air Theory and Computations, by Elmo G. Harris, C. E., Professor of Civil Engineering, Missouri School of Mines, in charge of Compressed Air and Hydraulics; Member of American Society of Civil Engineers. McGraw-Hill Book Company, New York. XII, 123 pages 6x9 inch, 14 cuts in the text, diagrams and tables. $1.50.

The following from the preface of this book assumes for it a status which we are compelled to accept. The author says: "As one advocating the increased application of compressed air and the more efficient use where at present applied, the author has prepared this volume for college-bred men, believing that such only, and only the best of such, should be entrusted with compressed air installations." On the first two pages there are assembled 38 formulas covering most of the problems involved in compressed air practice and the body of the work is devoted to their derivation and application, with copious practical examples. Following this are several original tables with others which are found in the standard pocketbooks.

TRADE PUBLICATIONS

Ingersoll Rand Products. Ingersoll-Rand Company, 11 Broadway, New York City. 80 pages standard size, 6x9 inches. This cannot be called a catalog; it merely gives brief sketches of the various types of machines and apparatus actually manufactured by the company, fuller description and detailed information being found in other publications which are furnished upon application. There is a long list of applications of compressed air and valuable tables of general application.

General Catalogue No. 102. C. W. Hunt Company, West New Brighton, New York. 112 pages and cover, 4x6½ inches. Briefly describes Coal Handling and Hoisting Machinery, Conveyors, "Industrial" Railways, Electric Locomotives, Electric and Steam Hoists, "Stevedore" Manila Rope. A noticeable feature is the effective use of little half tones, many of them less than one square inch.

From the Rotary Meter Company, 280 Broadway, N. Y. City, comes a brochure (without formal title) of 24 pages, 10¼x13½ inches, illustrating various applications of the meters manufactured by the company. These are used chiefly for gas and have capacities up to 150,000 cubic feet per hour or over. They are of course applicable to the measurement of air also within certain limits of pressure and volume.

Remington Kerosene Oil engines, Marine and Stationary. Remington Oil Engine Company, Stamford, Ct. 32 pages and cover 5⅜x7⅝ inches, copiously illustrated. These engines are of the valveless type, delivering a power impulse in each cylinder for each shaft revolution. Ignition is caused by a plug which remains red hot all the time when running. The engine has the advantage of using a cheap grade of fuel and avoiding all danger of explosion and is used with great success in small boats as well as for all stationary service.

COSTS OF WATER STORAGE

. The latest issue to hand of the Barge Canal Bulletin gives an interesting account of the Delta reservoir under construction for securing a reliable water supply for the canal, the article concluding with a comparison of costs of various other reservoirs. The Delta reservoir may be expected to cost some $75 per million gallons of available capacity (including nearly $25 for land damages). Among large municipal water-supply basins in the Eastern States the Wachusett cost (exclusive of soil-stripping) about $135 (including about $60 for real estate), and the Ashokan is expected to cost $180, while the three principal projects of the New York State Water Supply Commission for power development and flood prevention are estimated at from $16 to $33 (the latter the figure for the Portage basin includes

$5 for real estate), and four great irrigating basins of the West, from $5 to $17 (including land at $0.20 to $1.16) per million gallons of available storage. For New York city work, $200 has been regarded as the normal cost of storage. In France few of the reservoirs have cost less than $100, many have exceeded $300 and some even $600. In India the cost of impounding water has been in several cases about $30 and in few more than $50. It thus appears that a rational comparison on this basis cannot be made without a detailed study of the conditions and requirements of individual cases; but these data seem to imply at least that in the Delta reservoir water is to be impounded at an expense relatively as low as in other Eastern basins of greater capacity, in which the unit cost should thus be less, and which have been chosen with like restrictions as to geographical location.

NOTES

An 18-in. rock drill, 9½ feet long, has recently been tested at Bendigo, Victoria, Australia, in the construction of wharves. The drill weighs about 3,000 lbs. and is capable of working in rock 40 to 50 ft. under water. The cylinder diameter is 8 ins. with a 12-in. stroke. The weight of the piston is 450 lbs.

Out of 1,690 steel hopper cars weighed during the month of April the average decrease in cars which had been weighed within one year, was 702 lbs.; on 478 cars weighed within two years, 1,052 lbs.; on 132 cars weighed within three years, 1,220 lbs.; 92 cars, four years, 1,242 lbs.; 75 cars, five years and over, 1,459 lbs. In May, 671 lbs. on one-year cars; 1,004 lbs. on two-year cars; 1,224 lbs. on three-year cars; 1,571 lbs. on four-year cars; 1,705 lbs. on five-year and over.

A strange gas explosion occurred at the Vandalia mine No. 10, near Dugger, Ind., when the roof of an abandoned room caved in and opened a small pocket of gas, which was ignited by the open lamps of the miners in an adjacent entry. Andrew Baxter was killed by a blow on the head. It is supposed that he was thrown by the force of the explosion against the side of the entry. Nine companions of Baxter who were in the entry with him escaped with their lives, but suffered severe bruises and burns.

The south shore of Buckeye Lake is proving to be a fine natural gas district, and the Ohio Fuel Supply Company, which has almost all of the territory in that district under lease, has recently drilled in two large wells. One of these tests over 3,000,000 cubic feet and the other over 4,000,000 cubic feet. The company now has several other wells under way in this district and this will be one of the sources of supply for the company this winter.

A coal dust burner using a jet of compressed air instead of a fan blast has been in successful operation for the past two years in a southern cement factory. Air at high pressure passes through a Koerting ejector nozzle and enters the kiln through a horizontal pipe. A vertical fuel supply opens into the horizontal pipe just beyond the discharge end of the nozzle, and between the nozzle and the kiln, the rapidly moving air-jet carrying the coal dust into the furnace.

A smoke preventer, known as the "Torpedo" apparatus, is in use in England. It is a hollow conical structure of special perforated firebrick blocks supported in the combustion chamber just back of the bridge wall and in the direct track of the gases from the grate. Air is admitted from a pipe passing through the ash pit. The firebrick blocks become red hot and the heated air readily combines with the unburned carbon and hydrocarbons. The makers are the Yorkshire Boiler Co., Ltd., of Leeds.

The six-mile summit tunnel of the Denver, Northwestern and Pacific Railway, planned some time ago, is now being seriously considered for construction. The proposed elevation is 9,190 ft. above sea level, while the present line across the range attains a summit elevation of 11,660 ft. at Corona. This summit is reached by grades as steep as 4 per cent., but the tunnel line would have grades not exceeding 0.7 per cent. The tunnel will be about 50 miles west of Denver.

The work on the new line from Arica, near the north end of Chile (formerly belonging to Peru), over the west range of the Andes to La Paz, in Bolivia, encounters serious obstacles. On a large part of the line there has been no rain for 40 years, and 75 miles of pipe line have been laid to secure water while building. From a point 26 miles from the sea, 1,955 ft. above it, the ruling grade is 165 ft. per mile for 17 miles, and there is then a section of cog-wheel track for 25 miles, with a grade of 317 ft. per mile. The summit, 119 miles from Arica, is reached at Laguna Blanca, at an elevation of 15,120 ft. The Bolivia end of the line is over a high plateau and not particularly difficult.

Among the diseases incident to certain trades, there is a peculiar one to which workers in plants manufacturing chromates are subject. The thinnest portion of the septum of the nose is attacked and is gradually eaten away until the two nostrils form one channel for a portion of the space inside the nose. The disease then seems to have no further effect on the health of the worker. Preventive measures are the use of some bland oil or ointment in the nose and taking care not to touch the nose when any dust containing chromates is on the fingers.

Lightning on September 13th caused serious damage in the oil field northwest of Lawrenceville, Ill. Twenty-five tanks were destroyed and in each case lightning started the blaze. The Ohio Oil Company, the Silurian Oil Company and the Bridgeport Oil Company lost 20 250-barrel tanks filled with crude oil and five 1,600-barrel tanks, all full. The lightning also struck the gas line of the Bridgeport Oil Company, tearing it up and setting fire to the gas. The gas had to be shut off from the pipe line in order to put out the fire.

Rapid tunnel advance was made on the Catskill Aqueduct during September, 1910. Heading 3 N. of the Wallkill Siphon tunnel made an advance of 523 ft., the full section excavation keeping even pace with the heading. This tunnel is circular, 17 ft. diameter inside of neat line. It lies mainly in Hudson River shale, and the work of this heading during the month was in alternating layers of slate and sandstone.

In a paper read before the Académie des Sciences, M. Mahler states that he finds that under the influence of dry air at 25 to 30 degs. Cent., 150 grammes of coal give rise in thirty hours to 1 cubic centimetre of carbon dioxide and 2.88 cubic centimetres of carbon monoxide. At 100 degs. Cent. the production of gas is nine times as great, and carbon dioxide predominates; but 100 degs. Cent. is very far from any ordinary storage temperature. It is shown that moist air has less effect, and thus justification is found for the practice of storing coal in the open, and spraying it in dry weather.

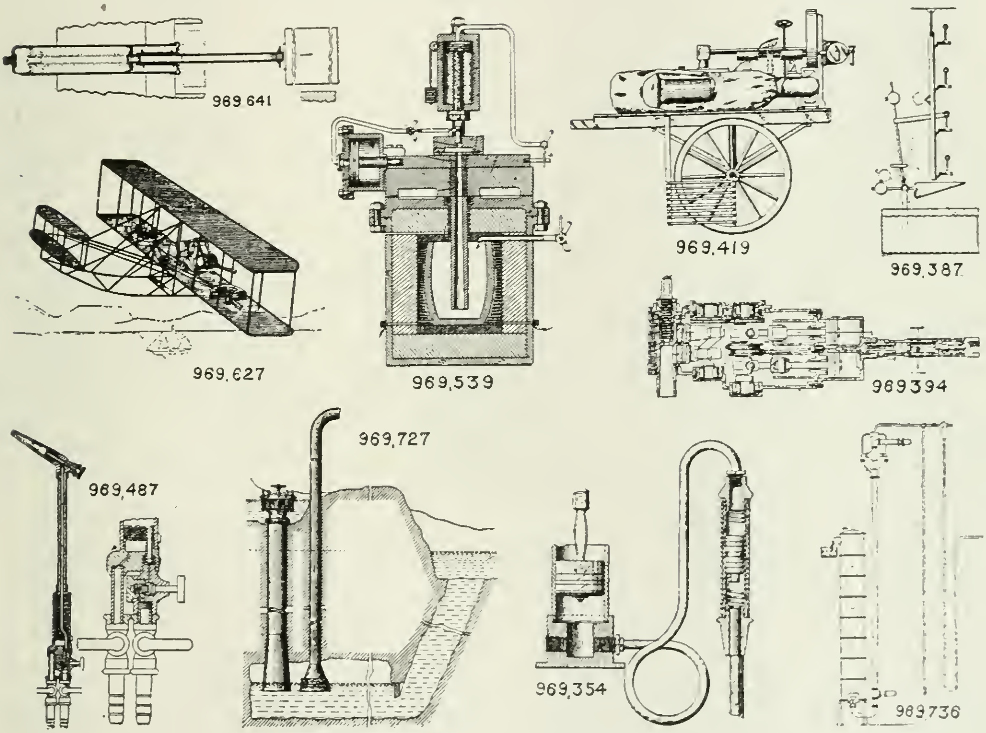
It is thought that the old Caylloma silver mines in Peru are at a greater elevation than any other big mine in the world. Their altitude varies between 14,000 and 17,000 feet. They were worked by the Spaniards in the sixteenth century and before that, it is believed, by the Incas. A year ago an English company prepared a hydro-electric plant for them. This plant is situated at an altitude of between 15,000 and 16,000 feet. It derives its power from a waterfall on the Santiago River, and in a dry season from Lake Huaillacho, one of the sources of the Amazon. The power is transmitted by cable about three miles.

A little over a year ago there were less than 100 aeroplanes in all Europe, principally in France. Since the first cross-channel flight, Bleriot has built 250 machines, duplicates of the machine in which he crossed from Calais to Dover, and Farman has built at his works over 100 biplanes. The machines built by other makers bring the French production to over 800 which have sold for something over $2,500,000. The small Bleriot monoplane sold at first for $2,000, but after its success in crossing the English channel, the price was raised and the latest type now costs from $3,100 to $5,100; the price of the Farman machine is $5,600; Voison, $4,600; Antoinette, $500; Wright, $5,000; and Sommer, $5,000.

The South Metropolitan Gas Company, which supplies with gas a large district in the southern part of London, had the selling price of its gas fixed in 1900 by Parliamentary enactment at 3s. 1d. (75 cts.) per 1,000 cu. ft., with the privilege of paying annual dividends not exceeding 4 per cent on its capital. For each penny (2 cts.) which the company should reduce the selling price of gas, it was privileged to add 2s. 8d. to the annual dividend on each £100 of its capital. This is equivalent to adding about 1/7 of 1 per cent. to its dividend for each penny reduction in the price of gas. The company is now selling gas at 11d. below the legal rate, or a net price of 53 cts. per 1,000 cu. ft., and has increased its dividends correspondingly, so that its stock now pays nearly 5½ per cent. Over one-third of the company's sales are in the poor districts of South London, where the gas is sold through slot meters.

According to the African papers there have been made during the past few years a great number of improvements in the dynamite works at Modderfontein, near Johannesburg, which have led to the discovery of a new explosive which in use does not develop noxious gases. The new explosive, a variety of gelignite, is cheaper as an explosive than the gelatine heretofore used. The principal saving resulting from its use consists in the fact that it reduces considerably the cost of ventilating the mines; and that work may be resumed in the latter as soon as a blast has been made. Experiments have also shown that much of the noxious gases resulting from the use of explosives in mines has come from the fuses and the paper shells in which the explosives are wrapped, so that in future there will be used no shells at all, or at least a simple tin-foil wrapping, and the ignition will be entirely by electric spark (relay ignition).

While cutting a deeper channel in the Mud River, Ohio, a dredge struck a water vein. The water gushed up and almost at the same time all the wells on adjoining farms went dry. Fears are entertained that Urbana may lose its supply if contemplated river improvements are carried out there, because a vein of water from which the supply is taken passes under the city in places only 15 feet from the surface.



PNEUMATIC PATENTS SEPTEMBER 6.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 6.

969,200. OCEAN AIRSHIP. REINHOLD SCHMIECHEN, Ledyard, Iowa.

969,287. AIR-WASHING APPARATUS. JOHN H. KINEALY, Ferguson, Mo.

969,354. PNEUMATIC STONE-MARKING TOOL. Cornelius S. Felumlee, Newark, Ohio.

969,394. PNEUMATIC DRILL. Reinhold A. Norling, Aurora, Ill.

969,419. COTTON-PICKING MACHINE. Harry James Stoops, Houston, Tex.

969,439. POCKET PNEUMATIC CUSHION. Calvert B. Archer, Milford, Mass.

969,441. VACUUM-CLEANER. George Backer, Syracuse, N. Y.

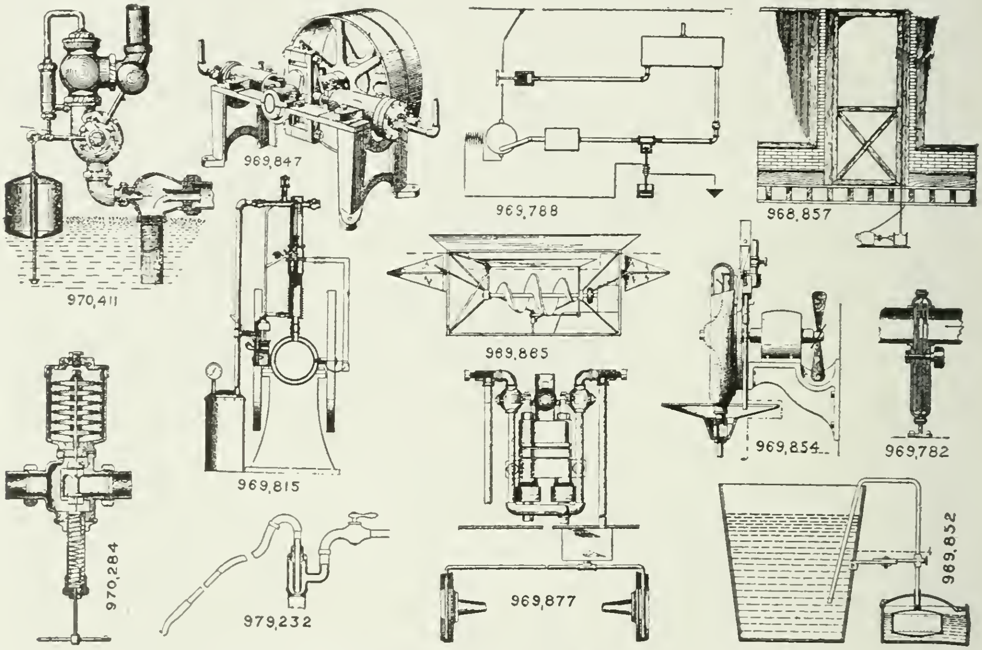
969,479. AUTOMATIC FLUID-PRESSURE-RETAINING VALVE. Charles W. Hurl, Altoona, Pa.

969,487. BLOWPIPE. Russell W. Magna, Holyoke, Mass., and Louis G. W. Carpenter, Philadelphia, Pa.

969,519. PRESSURE-REGULATOR. John Rowland Brown, Mansfield, Ohio.

969,522. WINDMILL. John A. Carlson, Chicago, Ill.

969,539. CASTING APPARATUS. Frederick T. Kitchen, New York, N. Y.



Pneumatic Patents September 13.

969,547. OZONIZER. Oscar Linder, Chicago, Ill.

969,587. WIND-MOTOR. William A. Williams, Olivet, S. D.

969,627. PROPELLING AND STEERING DEVICE FOR AIRSHIPS. Edward Hoult, New Westminster, British Columbia, Canada.

969,637. AIR, STEAM, OR HOT-WATER COUPLING. George N. Knapp, St. Louis, Mo.

969,641. AIR-CHECK FOR SLIDING DOORS. Homer Laughlin, Jr., Los Angeles, Cal., and Daniel Schuyler, Bridgeport, Conn.

969,727. WATER-ELEVATING APPARATUS. Olaf A. Roed, Denver, Colo.

1. The combination with a subterranean chamber and a water supply source above the chamber, the latter having an outlet above the top of the chamber but below the source of supply, of an open-ended conduit extending downwardly from the source of supply, its lower extremity protruding into the chamber, the upper extremity of the pipe being equipped with means for introducing air into the water by suction due to the downflow from the source, and a standpipe whose lower end is open and protruding into said chamber, the lower portion of the standpipe within the chamber being perforated for the entrance of air, after the air pressure has forced the water in the chamber downward to uncover said openings.

969,736. APPARATUS FOR STERILIZING AND OXIDIZING LIQUIDS WITH OZONE. Alexander H. Twombly, Summit, N. J.

SEPTEMBER 13.

969,772. SYSTEM AND APPARATUS FOR PROPELLING VEHICLES BY COMPRESSED AIR. Julius O. Cobb, Milwaukee, Wis.

1. The combination with a track and a car movable thereon, of propelling vanes carried by the car for propelling it in one direction, other propelling vanes also carried by the car for propelling it in the opposite direction, nozzles adapted to direct compressed air against said vanes for propelling the car, a pipe to conduct compressed air to said nozzles, valves to control the flow of compressed air from said nozzles and skees carried by the car and operable therefrom to actuate said valves.

969,782. FLUID PULSATING APPARATUS. Charles C. Glidden, Birmingham, Ala.

969,788. FLUID-PRESSURE SYSTEM. Charles E. Lord, Norwood, Ohio.

969,815. STARTING DEVICE FOR INTERNAL-COMBUSTION ENGINES. Frank H. Walker,, Atwood, Kans.

1. The combination with an internal combustion engine, of a carbureter, means to generate and store compressed air, a pipe connecting said means with the engine cylinder, having branches extending into and from the carbureter, a starting valve in said pipe, and means actuated by said first named means to automatically close the starting valve when the engine starts.

969,847. PNEUMATIC PUMP. Thomas Davis, Orange, N. J.

969,852. DRINKING-FOUNTAIN FOR POULTRY. Frank Enos, Jr., Norwich, Conn.

969,854. HUMIDIFIER. John W. Fries, Winston, Salem, N. C.

969,857. FLY-FRIGHTENER. August W. Grove, Chicago, Ill.

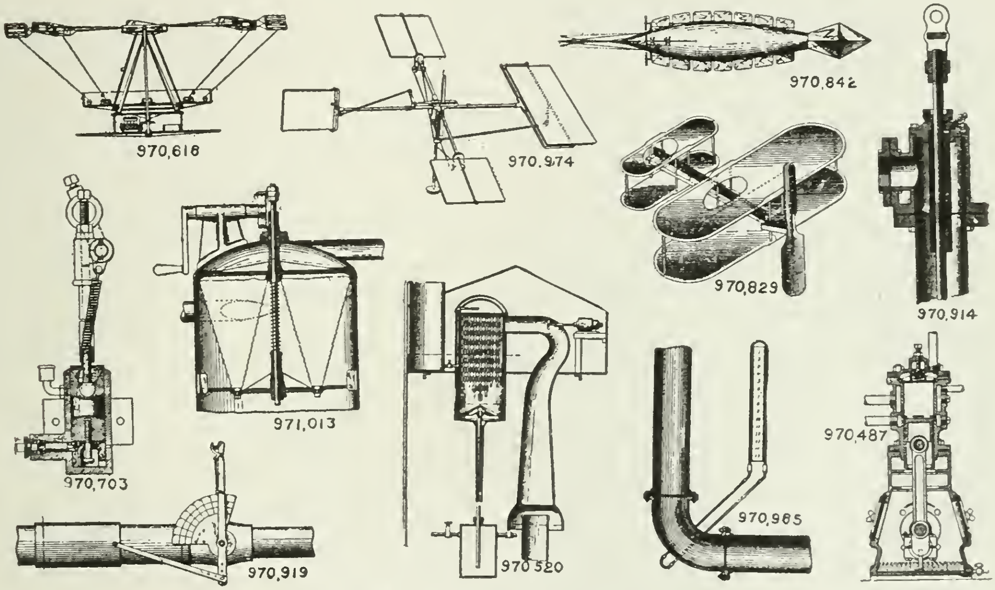
In a device of the kind described, the combination with a door, a motor, a blower operated by said motor, pipes connected to said blower and extending adjacent the vertical free edge and upper longitudinal edge of said door, said pipes having openings formed therein for directing a blast of air from the blower, and means carried by the door jamb and the door for automatically starting and stopping the motor when said door is opened and closed, respectively, substantially as described.

969,865. AEROPLANE. Andrew A. Heil, St. Louis, Mo.

969,877. AIR-BRAKE SYSTEM. Oscar Johnson, Chicago, Ill.

970,183. PNEUMATIC STACKER. George F. Conner, Port Huron, Mich.

970,232. VACUUM CLEANING APPARATUS. William H. Jakway, Syracuse, N. Y.



Pneumatic Patents September 20.

970,284. FLUID-PRESSURE VALVE-REGULATOR. Thomas M. Wilkins, East Randolph, N. Y.

970,411. VALVE MECHANISM FOR CONTROLLING FLUID ADMISSION. George Woodall, New York, N. Y.

SEPTEMBER 20.

970,487. AIR-COMPRESSOR. John Willis Gardner, Quincy, Ill.

970,519. SMOKE SEPARATOR AND PURIFIER. Victor E. Lombard, Fort Smith, Ark.

970,520. SMOKE AND FUME CONSUMING APPARATUS. Victor E. Lombard, Fort Smith, Ark.

970,616. FLYING-MACHINE. Thomas A. Edison, Llewellyn Park, Orange, N. J.

970,621. CAN-TESTING MACHINE. Charles W. Graham, Rome, N. Y.

970,623. PROCESS OF PRODUCING PURE OR MIXED AERIFORM ENVIRONMENTS. Henry J. Randolph Hemming, Washington, D. C.

970,703. MECHANICAL BELL-RINGER. George J. Gollmar, Baraboo, Wis.

970,771. FLYING-MACHINE. John W. Wilson, Boston, Mass.

970,829. TOY-FLYING-MACHINE. Isaac W. Humphrey and Harry A. Spurgeon, Dayton, Ohio.

970,842. AERIAL NAVIGATION. Richard P. Marable, Yuma, Ariz.

970,914. HYDROPNEUMATIC PUMP. Jesse B. Garber, Salem, Ohio.

970,919. AIR AND GAS MIXING DEVICE. Stephen H. Hale, Neodesha, Kans.

970,923. MEANS FOR MEASURING OR ANALYZING GASEOUS MIXTURES. Bertrand Chase Hinman, London, England.

970,956. PNEUMATIC STACKER. Frederick L. Ruddell, Georgetown, Ontario, Canada.

970,965. METHOD OF MEASURING THE FLOW OF FLUIDS. James Buckner Speed, Berkeley, Cal.

2. A process of measuring the rate of flow of a fluid which consists first in causing the fluid to flow through a curved conduit which is filled by the fluid and has a uniform circular cross section, and the center line thereof a constant radius of curvature for a part at least of the length of the curved portion; second, in measuring the difference between the pressures on the inner surfaces of the concave and the convex sides of said part; third, in computing the flow according to a suitable rule which takes into account the diameter of the circular section, the radius of curvature of the curved conduit where it is uniform, and the said difference in pressure.

970,974. FLYING-MACHINE. Peter Robert Torbrand, Denver, Colo.

971,013. DUST-COLLECTOR FOR VACUUM-CLEANERS. Friend W. Smith, Jr., Bridgeport, Conn.

SEPTEMBER 27.

971,030. AEROPLANE. William H. Fauber, Nanterre, France.

971,044. HAND VACUUM-CLEANER. Charles G. Hutchinson, New York, N. Y.

971,047. VENTILATING-VALVE. George E. Knowles, New York, N. Y.

971,069. CONTROLLING-VALVE FOR FLUID-OPERATED MOTORS. Charles Algernon Parsons, George Gerald Stoney, Alfred Quintin Carnegie and Albert William Bowerbank, Newcastle-upon-Tyne, England.

971,099. GAS-CONTROLLER. Fred Elliott Youngs, Detroit, Mich.

971,175. AIR-COMPRESSING APPARATUS. Lyman B. De Camp, Berkeley, Cal.

1. The combination, of an air compressor, a pressure tank connected with the main of a water system, such main, a motor connected to drive the air compressor, a source of power to operate the motor, power-controlling means to turn power on and off the motor, a float in the tank connected to operate said power-controlling means and means to turn on and off the power as the water rises and falls in the pressure tank, an air pipe connecting the air compressor and air tank, air check means between the compressor and air tank, and a valved outlet from the tank.

971,188. ROTARY PUMP ON AIR-COMPRESSOR. Charles R. Gether, Milwaukee, Wis.

971,215. VACUUM-CLEANER. William H. Rakestraw, Bloomington, Ill.

971,223. HAMMER-DRILL. Albert H. Taylor, Easton, Pa.

971,227. DEVICE FOR DAMPING THE AIR IN CLOSED ROOMS. Karl Ulrich, Zweibrucken, Germany.

971,235. FLYING-MACHINE. Maurice Ackerman, Washington, D. C.

971,248. HUMIDIFYING APPARATUS. Willis H. Carrier, Buffalo, N. Y.

1. The combination of a humidifier, an auxiliary humidifier which is supplied with humidified air from said first humidifier and is provided with additional humidifying means, and means controlled automatically by the humidity of the air in the vicinity of said auxiliary humidifier for regulating the action of its humidifying means, substantially as set forth.

971,275. FLUID-PRESSURE REGULATOR. Max Jaspersen, Hamburg, Germany.

971,297. ART OF TREATING AIR FOR USE IN METALLURGICAL PROCESSES. John B. Miles, St. Davids, Pa.

1. In the art of treating air, compressing the air, and cooling the air to a temperature varying as the pressure of the compressed air varies so that the amount of moisture in a pound of air remains constant.

971,298. SUCTION-BOX VACUUM-REGULATOR FOR PAPER-MACHINES. William H. Millspaugh, Sandusky, Ohio.

971-326. AIR-BRAKE PROTECTION-VALVE. Walter V. Tubner, Wilkinsburg, Pa.

971,327. TRIPLE-VALVE DEVICE. Walter V. Turner, Edgewood, Pa.

971,329. PNEUMATIC STACKER. James A. Walsh, Indianapolis, Ind.

971,358. AERIAL MACHINE. Leonard E. Clawson, San Francisco, Cal.

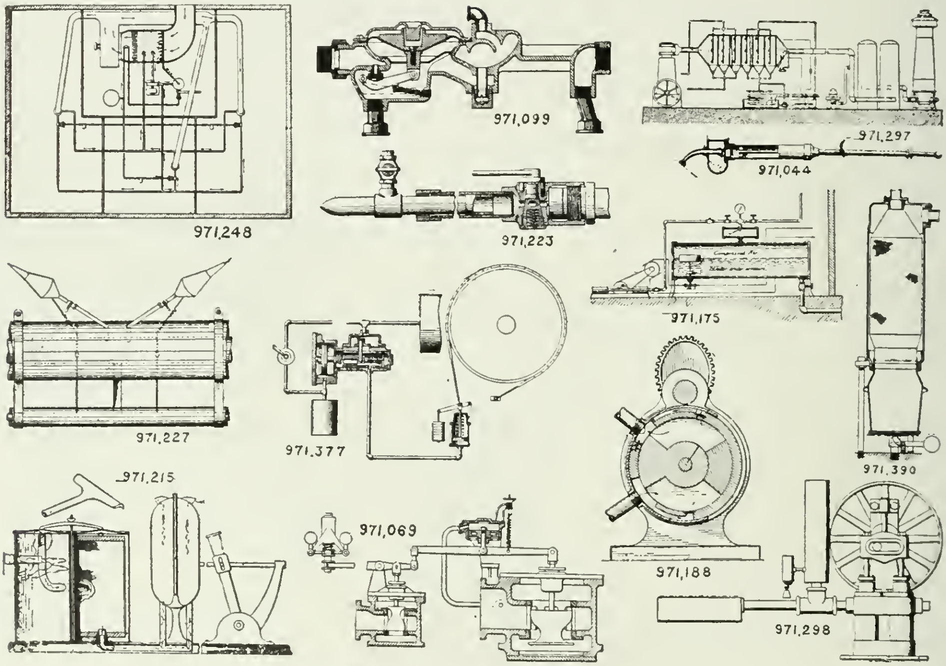
971,377. AUTOMATIC HOIST-BRAKE AND CLUTCH ADJUSTER. Herbert T. Herr, Denver, Colo.

2. In a hoist brake, the combination with a spring for applying the brake, of a brake cylinder and a piston therein operated by fluid under pressure to oppose the spring, and means operating upon a reduction in fluid pressure to release air from said brake cylinder and cause the spring to apply the brake.

971,379. AIRSHIP. David Hillis, Des Moines, Iowa.

971,390. DUST-COLLECTOR. Frank J. Matchette, Milwaukee, Wis.

1. In a dust collector, the combination with a casing having an opening in the lower part thereof, a dust and air inlet and an air outlet, of a strainer bag inclosed in said casing between said inlet and outlet, and having an opening in its lower end, an elastic packing ring attached to the strainer bag around the opening in the lower end thereof and fitting the casing around the opening in the lower part thereof, and a removable closure fitted to said packing ring.



Pneumatic Patents September 27.

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC.

Vol. XV DECEMBER, 1910 No. 12

THE ENGINEER OF THE MINE HOIST

I don't want to boast nor nuthin',
But I've got this much to say;
If it wasn't for me that knows my biz
There'd be just hell to pay—
For I lowers the miners and hoists 'em too,
Some several times a day.

A human life don't count for much
When it's off in some foreign land;
But it means a lot when you're here on the hoist
With that human life in your hand—
And multiply that by the number on shift
And you'll see just how I stand.

A little mistake and they'd hit the sheaves,
Or land in the watery sump;
Or spatter around on the plates and guides
With nary a chance to jump—
But instead of that I lands 'em safe
With scarcely a jolt or jump.

I drops the cage to a station floor
So even and accurate, too,
That a car rolls on without a jolt
The way it was meant to do.
And when she is loaded I hoists her up,
Like a limited train goes through.

Now, I don't want to boast nor nuthin',
But, as I began to say,
I reckon a job like mine is worth
The price that the bosses pay—
For I hoists the miners and lowers 'em down
Some several times a day.

Berton Braley in Saturday Evening Post.

A SIPHON SPILLWAY ON THE BARGE CANAL

BARGE CANAL BULLETIN.

At three localities on the Champlain division of the Barge canal there are being built structures of a new type—intended to fill the office of spillway or waste-weir, and designed by Mr. George F. Stickney, Supervising Engineer. Two of these will discharge from the canal and into an adjacent stream the surplus waters that accumulate from an intercepted drainage area.

As a widely fluctuating canal water-surface is to be avoided, if possible, it is necessary to get rid of any surplus, and if this water may at times flow in rapidly, it must be discharged with equal rapidity. Ordinarily this has been accomplished by a waste-weir with sufficient length of spillway to pass the required amount in the given time. However, when the volume is large, the spillway must be long, and sometimes conditions exist which make a long spillway undesirable or even impossible. The presence of such conditions, especially in the case of one of these three structures—the one at Whitehall—has led to the designing and introduction of this new structure, a type which will perform the same amount of work as an ordinary spillway, but with a decided reduction in length, the ratio varying from one to three to one to five at these particular spillways, depending, of course, on the available head of water, while at the same time the economy in cost of construction is considerable.

These structures have been designated "siphon spillways." It is believed that in them the siphon principle is used for the first time to create a spillway of any considerable size.

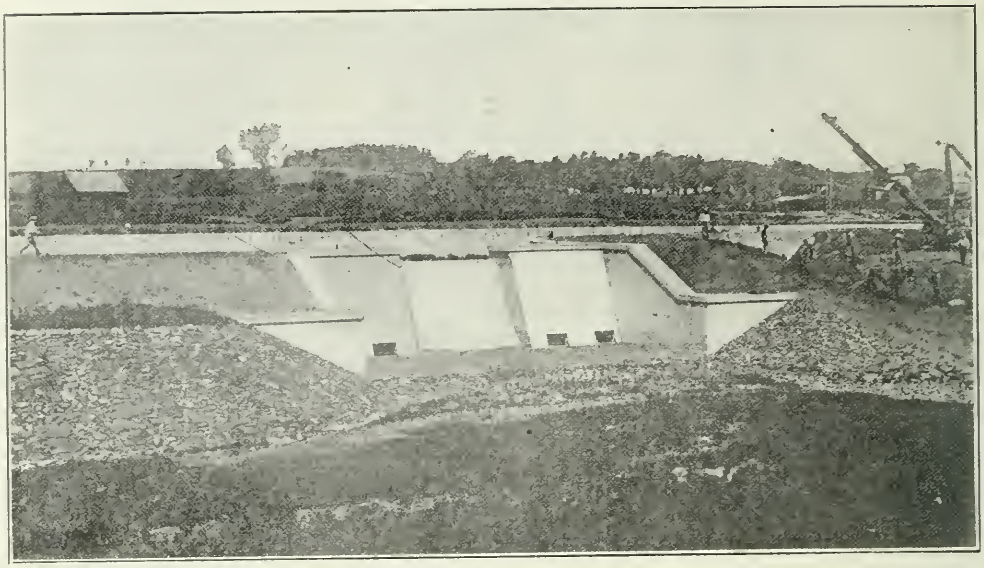


FIG. 1. SIPHON SPILLWAY AT SMITH'S BASIN.

The siphon action will be entirely automatic, in both the starting and stopping of the flow.

As previously stated; there are three of these siphon spillways planned for the Champlain canal. These differ in size and in the number of siphons employed. One of the spillways is at Whitehall, another at Fort Edward and a third at Lock No. 9, which is near the hamlet of Smiths Basin.

The Spillway at Lock No. 9 is completed. It is situated on the summit level of the canal and this level receives the drainage from a small area of adjacent land, the maximum inflow amounting to some 700 cu. ft. per sec. in times of heavy rainfall. It was desired to provide for this volume of flow and also to limit the fluctuation of water-surface to about one foot. The ordinary waste-weir of a capacity sufficient to take care of this flow, with a depth of only 1 ft. of water on the crest, would require a spillway 200 ft. long. The siphon spillway, however, measures but 57 ft. between abutments, and it accomplishes the same result. The structure consists of four siphons and a waste-weir 20 ft. long, the purpose of the weir section being to serve as a gap to carry off floating debris. Each of the siphons has an area of 7¾ sq. ft. Acting under a head of 10½ ft., each one will discharge approximately 160 cu. ft. per sec.; while the waste-weir, with a depth of 1 ft. of water on the crest, will have a discharge of 70 cu. ft. per sec., the total discharge for the whole structure thus being about 710 cu. ft. per sec. The inlet of the siphon is placed well below the water-surface and is protected by a screen to prevent the entrance of floating bodies that might happen to drift into the pipe and lodge in one of the several bends of the siphon. In order to reduce the loss of head

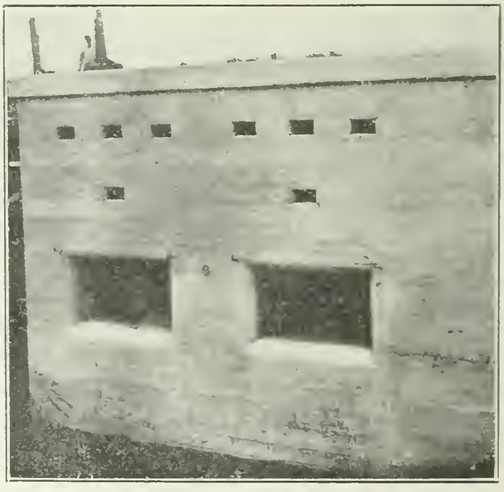
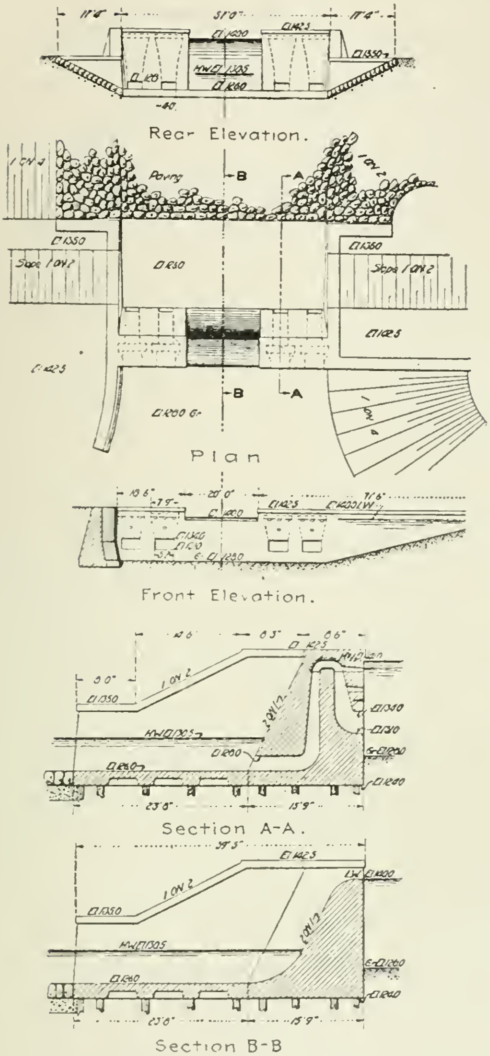


FIG. 3. INTAKES AND VENTS.



Rear Elevation.

Plan

Front Elevation.

Section A-A.

Section B-B

DETAILS OF SIPHON SPILLWAY.

due to entry, the inlet is flared out to double the normal area. As the siphon will not come into action until completely filled with water, it was necessary to limit the height at the crown to 1 ft., but the necessary area was obtained at this point by increasing the width. From the crown to the outlet the siphon is practically uniform in area, though the dimensions were changed from 1 × 7¾ ft. to 2 × 4 ft., in order to give a better section to the masonry and also to facilitate the removal of forms used in construction. At the crown, where the removal of forms would have been difficult, iron castings were provided, which were left in the masonry. Three vents, each 6 ins. high × 12 ins. long, pierce the wall at low-water level above the inlet of each siphon. When the water has been drawn down to this level, air will enter through these vents and stop the flow through the siphon. A little below these vents a single opening of the same size acts as a precautionary vent to break the flow in case the upper openings become clogged in any way—by freezing or otherwise.

DUST IN CITY AIR

By Dr. George A. Soper.

Closely associated with the bacteria in the causation of disease are the solid particles which air contains in the form of dust. A committee to which I happen to belong was appointed by the American Public Health Association to draw up standard methods for the analysis of air, and reported that the physical properties of the atmosphere are of more consequence to health than the chemical or bacteriological constituents, meaning thereby to place emphasis upon the importance of temperature and humidity, and especially upon the presence of dust, which contaminated air often contains.

Dust is directly or indirectly the greatest enemy of man. Aside from the enormous cost involved in the continuous warfare which is waged against it for the sake of mere cleanness, dust is dangerous to breathe. It is dangerous to breathe, not so much on account of the microbes which it contains, as because it is dust. Physiologists assert that nothing so predisposes the delicate structures of the nose, throat and lungs to invasion by microbes of respiratory diseases, and we can all bear testimony to the irritating and aggravating effect which a dust-laden atmosphere produces upon the sore throats and colds which most of us experience every winter.

It is probably the very commonness of the dust evil which makes us so indifferent to it, as we must frankly confess ourselves to be. We forget that it is composed of the offscourings of our bodies and the wear and tear of our clothing, habitations, shops, factories and streets, not to mention the comminuted refuse of our kitchens and the desiccated excrement of horses upon the public highways. We are too indifferent to the way in which it floats in and out of our houses and contaminates the food we eat, the water we drink and the air we breathe.

Sanitarians have given much attention to dust, and have divided it into several classes according to its harmful effects upon the human organism. In the dusty trades, so called, the most destructive dusts are those whose composition is most unlike the soft and yielding structure of the respiratory apparatus. The grinding and polishing of metals, and the cutting of hard stone, are, because of their dust, among the most hazardous occupations in which a person can engage. "Grinders' rot" is a name popularly employed for the tuberculosis which commonly affects knife grinders before middle age. Pneumokoniosis is a longer and more scientific term by which the medical profession designates diseases of the lungs brought on by dust of whatever kind.

There are many dusty occupations, each with a startling mortality peculiar to itself. Upon investigation, the immediate cause of death is always found to be the same—tuberculosis and pneumonia. The direct cause of death is disease contracted from germs thrown off perhaps by a fellow workman; the indirect cause is a pair of lungs which have lost their normal resilience and peculiar spongy texture and have taken on a hard consistency and dull, somber hue from the dust which they have absorbed. The lungs of coal miners are black the lungs of men and women who have lived for some years in cities are gray, and the lungs of country people are a bright, healthy red.

Such being some of the conditions of contaminated air, let us glance for a moment at their remedy. We have found that the contamination of air, whether chemical, microbic or particulate, is due to its employment in some way for the use and convenience of man. Air becomes polluted just as water becomes polluted. In eash case a fundamental requirement of sanitary science is ignored. From its controlling importance and universal application we may term this requirement the cardinal law of sanitation. This law demands that waste products shall be carried promptly from their source, kept always within control and be inoffensively disposed of.

It is more difficult to observe this law in dealing with air than with water, and in no branch of sanitation will it be found possible to obey it perfectly. It is, nevertheless, our duty to keep its provisions prominently in mind, for no substantial success can be accomplished otherwise.

If the waste products of our furnaces and our factories were to be kept under control until they were utilized or otherwise destroyed, consider for a moment the immense saving in money and human life which would result. If persons sick with the lesser respiratory diseases, not to mention consumptives, were to isolate themselves as much as practicable, or, at least, refrain from visiting crowded assemblages, consider the enormous saving in life and health which would follow. If the filthy dust of our streets were to be kept from our lungs by efficient methods of street cleaning, consider the progress in decency and order, not to mention health, which this reform would accomplish.

The conservation of health has no better field for effective operation than systematic warfare against dust. With one notable exception, the use of oil on thoroughfares and railroads, no new method of combating this evil has been developed by sanitary science in recent years, while the quantities of dust produced and the harm which it has done have enormously increased with the growth of our cities. As matters stand, the greatest dust scavenger is the atmosphere. Into it we cast the dust of our houses with the same heedlessness with which we dump our sewage into the water courses. We do not stop to think that this air must serve to ventilate our dwellings and shops, and the lungs of our children and ourselves.

IRON DUST.

I found that there was produced in the New York subway one ton of dust for every mile every month from the brake shoes alone. At about the same time I estimated there was produced about a ton a mile a month on the elevated roads of New York. I did not take into account the wear on the rails or on the wheels. But so great was the wear on the rails in the subway that the Interboro Company had a special steel made for the rails. They got tired of renewing them.

The consumption of iron in New York, and the resolution of the metal into dust, is the most remarkable, most disfiguring element in the city air. If you look at any of our white buildings, such as the Metropolitan Life Insurance Building, on Twenty-third street and Fourth avenue, you will see it is stained from top to bottom—stained yellow. It is stained much more deeply at the bottom than at the top. If you examine the Chemical Bank building on Broadway, you will find the same is true. But there the stain is more marked.

Our City Hall itself was cleaned by sand-blasting about three years ago, and when I entered it to-day I was struck by the deep orange color of the lower part of the building. Now that is in the center of a little park. The iron dust produced by the wear and tear of trolley cars on the surface, of those of the subway nearby and of the elevated road, not to mention the great amount of iron dust from machinery and from horses' shoes, had been carried by the air to the City Hall, and there, by the aid of moisture, had become resolved into a yellow stain.

When the Metropolitan Life Building began to be stained, I discussed the question with some of the engineers and architects of that building, and suggested to them the cause of the trouble. It is one of the largest buildings in the city, and one of the most ornamental. Their view was that there was iron in the marble. But I went to Tuckahoe, where the marble came from, and found that houses had been built in the country not far from there of the same material and had stood many years without any stain. And then I collected dust from the Metropolitan Building—collected it on nearly every floor up to the top, which is a great distance from the sidewalk. I always found iron particles in the dust, and always in sufficient amount to account for the results. It would be an interesting thing for any one here who is at all concerned about dust, and curious to know how much iron there is floating around in the atmosphere he breathes, to scrape up a little dust,—perhaps from his book-case, or somewhere else in his home or office,—take a common ten- or fifteen-cent horseshoe magnet and pass it over the dust. Or, preferably, if the dust is scattered on a piece of paper, take the magnet and pass it back and forth under the paper. In the last case, with the magnet moving under the paper, the sharp eye will see some of the particles rearing themselves on their hind legs, so to speak, and waving back and forth in accordance with the amount of magnetic attraction beneath.

I have never found any dust in the city of New York that has not had iron in it. Unless dissolved by long-continued exposure to the weather, the particles retain their sharp, blade-like form.

There is a way to prevent much of the iron dust of the subway, and that way has been employed in the Central Underground of London. The Yerkes Tubes, of London, so called, have given up iron brake shoes and use a fiber brake shoe. These brake shoes are economical and prove an excellent remedy where such an amount of disfiguring dust is produced as in the New York subway.—*Journal of Association of Engineering Societies.*

COMPRESSED AIR FOR STIFFENING BEAMS, STRUTS, FLAT SURFACES

Prof. Perry, of the Royal College of Science, South Kensington, England, recently published a letter in which he called attention to the possibility of stiffening flexible materials by inflating them with compressed air, mentioning the bicycle tire and the long sausage-like india-rubber toy sold on the streets, as well-known examples. He suggested that the idea may be made very valuable in the design of metal structures, because with the proper internal pressure the compressive stresses can be reduced to zero. It is the compressive stresses that complicate structures and make bracing necessary that also greatly increases weight. The idea, now of special interest in view of the development of the aeroplane, is treated in Perry's "Applied Mechanics" in part as follows:

"A tensile load applied to extend a beam may not only diminish the greatest compressive stress, but also the tensile stress. Again, there are many cases of beams or infinitely flat arches in which there is no tensile stress anywhere. In such cases, of course, the earth takes the necessary tensile load. When the pneumatic wheel tire was invented, Prof. Fitzgerald pointed out that columns to support loads, and military bridges easy to pack and unpack might be made of inflated tubes, the solid material being everywhere in tension. . . . In a thin straight tube of circular section, if the greatest bending moment is M and

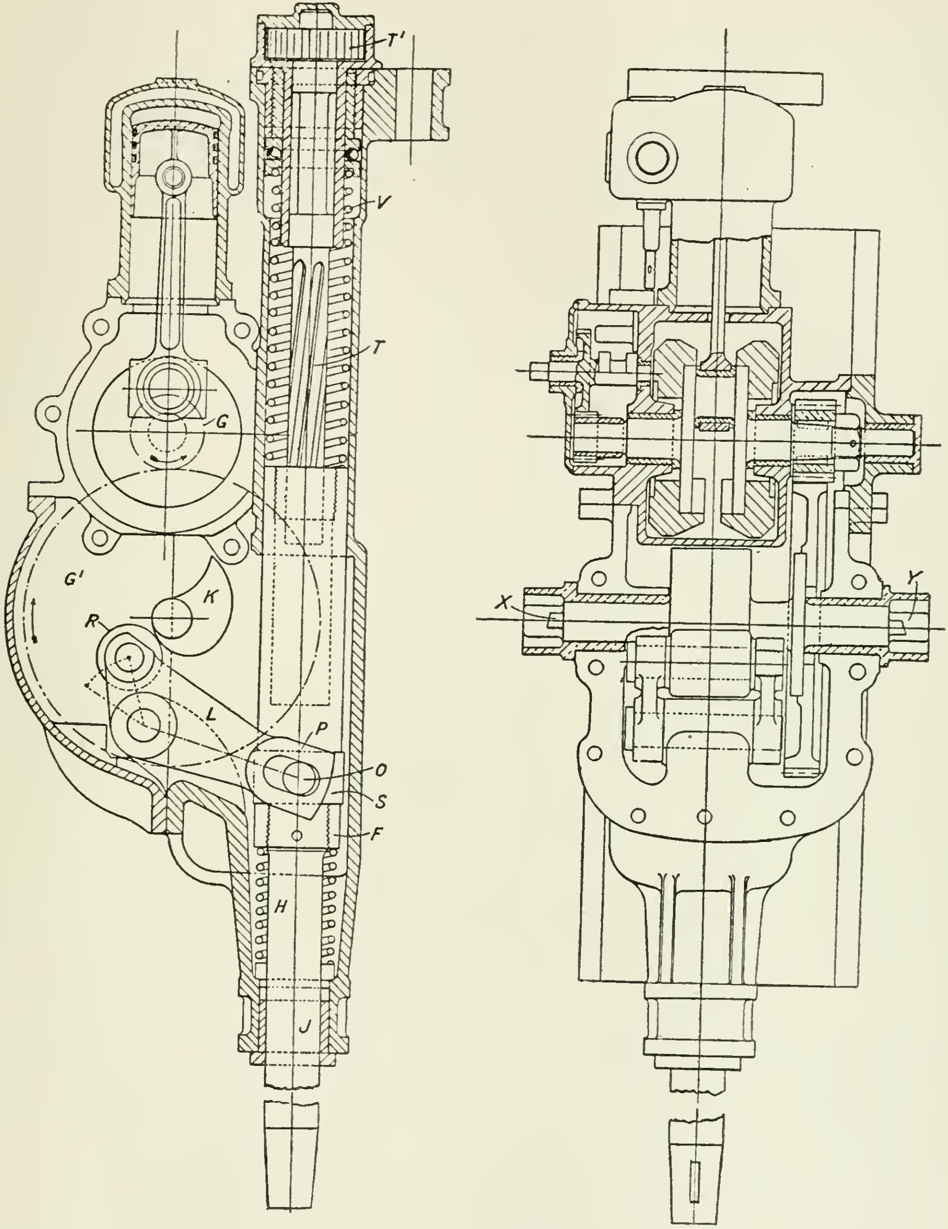
R is the radius, t the small thickness of the material, the compressive stress anywhere due to bending is $\frac{M}{\pi R^3 t} y$, where y is the distance from the diameter which is the neutral line of the section on the compressive side. The greatest compressive stress is $M / \pi R^2 t$. Now imagine the tube to be subjected to internal fluid pressure P above that of the atmosphere; there is a tensile end-long stress $P \pi R^2 \div 2 \pi R t$ or $PR/2t$, and hence the greatest compressives stress is $M / \pi R2 t - PR / 2t$. This is just 0 when $P = 2M / \pi R^3$. The greatest tensile endlong stress is then, of course, PR/t; but this is equal to the lateral tensile stress which the mere internal pressure produces. When, therefore, the internal pressure is just sufficient to remove all compressive stress in the material, the tensile stress, where it is greatest is the *same in all directions*, and is $2M / \pi R^2 t$. We see, therefore, that great loads may be carried by inflated tubes of thin material if they are only large enough in diameter, or by a bundle of small tubes. . . . One may go far in speculation on this idea—rigidity gained by using thin material and subjecting it to internal fluid pressure, so that there shall be no compressive stress. The great ships of the future may owe their stiffness and strength to the general use of fluid pressure in those parts of them where cargo is stored, and the same pressure which gives strength may serve to keep out the sea in case of a leak. It is the means by which the leaves of plants are made rigid. Similarly, large flat areas might be made of considerable size by fastening together two plane sheets by means of many connecting ties so that they may not balloon out, and then inflating them like an air cushion. Aeroplanes of sufficient size to support a man by Lilienthal's method can be made with comparatively small internal fluid pressures, and are not liable to make splinters when they fall to the ground, these splinters being a cause of considerable risk with aeroplanes made with sticks as stiffeners. Kites much larger than those suggested for military purposes might be made, in which the whole kite might be like an air cushion, or thin tubes with compressed air might take the place of the present bamboo framework. The inflation might be maintained automatically.

"Again, a thin tube of radius R and thickness t has to act as a column carrying a load W, and this is the load which is carried when there is no axial tensile stress. The pressure of the fluid inside being P, we have $\pi R^2 P = W$. Also the lateral tensile stress produced in the material is PR/t or $\frac{W}{\pi Rt}$, so that great loads may be supported by inflated tubes of thin material if they are large enough in diameter. Thus, for example, a tower of thin steel 1,000 feet high would have in it a lateral tensile stress of only three tons to the square inch, due to its own weight and the necessary fluid pressure. Being all in tension there is no danger of instability such as exists in ordinary pillars. If large in diameter, the hemisperical top cap becomes of importance as a load. Any moderate diameter like 20 feet would bear many tons on the top in addition to the weight of the structure itself. Thus, a tower 1,000 feet high and 20 feet in diameter and 0.01 foot thick would itself weigh about 125 tons. Its hemispherical cap would weigh 6.3 tons, and it would support 325 tons on its top. The internal pressure would be 23 pounds per square inch and the tensile stress 10 tons per square inch. There would be no compressive stress."

The fatal objection to most of the above would seem to be the necessity of an absolute guarantee that the pressure would be maintained, an apparent impossibility.

A SOUTH AFRICAN AIR LIFT VAT

At the Luipaardsvlei Estate a new type of air lift vat has been installed by Dr. Caldecott, consulting metallurgist to the Consolidated Gold Fields of South Africa, and is working most satisfactorily. The vat is employed for aerating accumulated slimes previous to treatment by cyanide. The vat differs from those erected in other mining fields of the world in that it is 30 feet high and 30 feet in diameter, whereas the usual type of air lift vat is 55 feet high and of much smaller diameter than the Luipaardsvlei installation. These tall and narrow vats have been very costly to operate, and the one employed by the Luipaardsvlei Estate Company, which has a capacity of 150 tons, has been proved to be a much more satisfactory device than the 55 feet vats with smaller diameter which have a capacity of only about 75 tons.



A GASOLENE DRIVEN ROCK DRILL

The cut here reproduced from *The Engineer*, London, shows the essential features of the Warsop gasoline rock drill, built at Chorley, England. There is a single-cylinder gasolene engine of not unusual type reducingly geared (4 to 1) to a shaft which carries a cam operating the short arm of a bell crank lever the long arm of which lifts the drill spindle and allows it to drop at each revolution, the gravity force of the blow being augmented by that of a long spring. The drill is mounted and fed and rotated by the usual devices, and being so self contained, or independent of compressor or generator, if it could be thought of as delivering a blow comparable with that of the usual steam or air driven drill, or of the electric air drill, it would be entitled to respectful consideration.

PNEUMATIC TESTS OF PIPE*

Last spring two separate corporations wishing to put in some pipe lines that would be absolutely tight when laid and in service, ordered from two separate manufacturers a quantity of cast-iron pipe, each purchaser specifying in addition to the usual hydrostatic test that each pipe be carefully tested with air, compressed to 50 pounds per square inch, and that while under this pressure soap and water suds be applied so as to reveal open or porous iron or defects which the hydraulic test had not developed. Because of this additional test and it being known that air will, when compressed, work through metals more rapidly than water, it was determined by the manufacturers to use nothing but the best grades of iron that would give a close and uniform texture.

The results were that in one case there were 4,954 pipes tested either hydrostatically or pneumatically; of this number 27 leaked under hydraulic pressure and 272 leaked under pneumatic pressure, those leaking under pneumatic pressure having already passed the hydraulic test: this makes a percentage of leaks of the whole quantity tested 0.545 of 1 per cent. for the hydraulic and approximately 5.5 per cent. for the pneumatic, or slightly over 6 per cent. for the two tests. In the other case there were 2,737 pipes tested, of which 14 leaked under hydraulic and 186 leaked under pneumatic pressure, the percentage being 0.511 of 1 per cent. for the hydraulic and approximately 6.8 per cent. for the pneumatic, or about 7.3 for both. Analyzing further you will notice that the percentage of hydraulic leaks to the total number was but about 6.2 per cent. of the total number of leaks, taking both jobs together. This proportion, however, would undoubtedly have been more evenly divided had the hydraulic pressure in testing been maintained for a longer period of time per pipe, for, as previously stated, air compressed will find its way through open or porous metal more rapidly than water compressed, but in view of the fact that all of the pipes were to be subjected to an air test subsequent to the hydraulic, both manufacturers depended more on developing leaks with the air than with the water. While it is true that both lots of pipe were laid for the purpose of carrying gas, the writer believes that in these days when the tendency is with all water works to operate as economically as possible and with as little loss of the commodity being dealt in, for the purpose of conserving the supplies already in use to their fullest extent before looking for new sources, or in considering the most economical way of conserving new sources of supply which are being considered, we should all consider seriously whether requiring a longer hydrostatic test, or in addition to the hydrostatic a pneumatic test of the pipe we purchase and lay, would not be good economy, even at the risk of having to pay slightly more for our material. In other words, whether the best is none too good, both in material and in laying, while the first cost may seem high will it not effect economies of both operation and commodity that will eventually prove considerable of a saving?

COTTON MILL HUMIDITY

When the average temperature in a mill, as on certain days in June, is 75 to 80 degrees, Fahrenheit, with a relative humidity of 55 to 65 per cent., absolute humidity of 5 to 6 grains of moisture per cubic foot of air, it is generally recognized to be the best condition for textile working. Such days are neither remarkably warm nor remarkably humid; far less humid in fact than some artificially moistened rooms in many mills, but the humidity is steady.

No up to date mill manager needs to be told that a certain amount of humidity is necessary in textile working.

Most mill managers have learned by experience that during part of the year, unhappily short in New England climate, everything works smoothly, while at other times there is trouble.

The up-to-date mill manager wants to produce at all times if possible under the conditions found in the fine June days when the work is at its best.

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*Paper before Central States Water Works Association by William R. Conard, Burlington, N. J.

Doing this is essentially a matter of artificial moistening of the atmosphere. Various attachments are applied to the cards and other machines because of claims that these different devices strengthen the yarn. We have pointed out that any mechanism that will attenuate or give a combing action to the fibres of cotton will weaken them to a certain extent.

This statement is proven by the examination of the waste returned to the picker room, it being no longer flexible or coherent. The effect of humidity in a textile mill is far more complex than appears at first sight, because cotton slightly moistened works more smoothly than when dry or too wet, the fibres being more flexible and coherent when properly moistened.

Humidifiers are to a mill, what the experienced overseer who understands the structure of the fibre and its peculiarities, so as to be able to judge at the time of mixing whether the cotton will lose twist per inch or gain twist per inch, is to a room. Many mill managers blame the trouble due to dry yarns to electrification, which of course, is favored by a dry atmosphere; but this is erroneous. A dry yarn and a moist yarn are mechanically two different things, and electrification is only an incidental trouble which is easily overcome by the same means that soothes the mechanical trouble.

If the mill manager wants to secure a uniform production, which is generally the demand from our mill managers, the material must be worked under uniform conditions, and here is where the humidifiers are valued.

The mill manager, that will not have artificial moistening in the mill of which he has charge, is standing in his own light, because he should know that the shuttle that works well in an atmosphere of 55 to 65 per cent. of relative humidity will stick in the box and give trouble at 75 to 80 per cent. humidity, and will rebound when the humidity falls to 40 or 35 per cent.

The cards will run well in an atmosphere of 65 to 70 per cent., but will continually sag in an atmosphere of 80 to 85 per cent., and the web will follow the doffer instead of being stripped by the comb in an atmosphere of 50 to 40.

Of course, conditions vary so much in certain sections and certain mills that no fixed rules are universally applicable, besides, the carder, spinner and weaver are all apt to think that they cannot have too much moist air, and they sometimes run their humidifiers when they had better not, for too much humidity is as bad as too little. There is a device that will regulate this state of affairs and it should be used to control the humidifiers automatically, and not by the overseers, as is generally the case in most mills.—*Wool and Cotton Reporter.*

THE UNSTABLE EQUILIBRIUM OF THE BALLOON

BY TECUMSEH SWIFT.

The prominent and popular engineering problem of the day is that of aviation. It has attacked the mechanical brain of the age and must work itself out, to results perhaps not yet in sight. Probably more of the readers of the *American Machinist* are thinking and talking upon this topic than upon any other, and it would seem to be eminently improper, if not impossible, for their favorite journal to ignore it, so that I feel that I need not offer an apology for my say on the subject, my only regret being that what I can tell in my present lucubration is almost entirely about how not to do it. This is, however, the first and most necessary thing to know in any case. The earlier history of any laboriously wrought success consists largely of the story of elimination, and generally of the practical abandonment of everything first tried or thought of. The elimination of the essentially worthless devices in aviation means a saving of time, of money and of life.

Wonderful is the perfect poise of the fish in the water, yet the devices by which it is maintained, though marvelously ingenious, are of the simplest character. The most alert and swiftest fish of prey with which we are acquainted, such, for instance, as the pike or the pickerel, seem to spend much of their time almost absolutely without change of position, watching and waiting in readiness to dart, as upon land the cat watches the bird or the mouse.

A suberged body charged with life forces and floating inert in the water is apparently free to move or to be moved in any direction, and that it should not is the most unlikely thing that would probably be predicted of it;

yet fish seem to be provided with the means of resisting or of counteracting the minutest disturbing forces and to be able to maintain their position when so desired apparently without effort, and in fact almost automatically, so that they seem even to sleep as if anchored.

To retain its position vertically, so that it will neither rise nor sink in the water, the body of the fish as a whole must have precisely the same specific gravity as the water which surrounds it, and means must be provided, and they are, for instant adjustment and correction of the specific gravity. The air bladder of the fish, normally filled with compressed air, is a device for the purpose which for simplicity, precision and effectiveness challenges the inventive faculty to surpass it. The air in the fish bladder must be always under more or less pressure, and the elasticity of it opposes a constantly maintained muscular tension in the body which incloses it. When the muscular tension is increased the air is still more compressed, giving the bladder a diminished volume, and the entire body of the fish in which the bladder is inclosed is correspondingly reduced in bulk, so that while its actual weight remains constant, its weight relatively to the weight of water displaced is increased and the tendency of the fish-body is to descend in the water. On the other hand, if the muscles which hold the air bladder and its contents in compression are relaxed the body of the fish will be distended and the fish will tend to rise in the water. When fish are not well and have not the strength to maintain the compression they float to the surface. If a mermaid belle in a ball room of the deep should faint away she would not sink to the floor but would float to the ceiling and become entangled among the chandeliers.

The air bladder of the fish has a still more delicate and responsible function than that of merely maintaining the precise specific gravity of the body. The stability of the fish laterally in the water is assured by the fact that the air bladder is located high in the body and the preponderance of weight is below it. The longitudinal, or fore-and-aft, trim of the fish is more difficult to adjust and maintain, as builders and operators of submarines have learned. This also the air bladder perfectly provides for, it being made of considerable length relatively to its diameter and also partitioned transversely or formed into two chambers, the muscular control of the fish transferring air from one chamber to the other as may be required.

The fish floating in liquid of uniform and unchanging weight and destiny is thus perfectly equipped, with slight local adjustments by the aid of the fins, for maintaining its position and poise as desired. The problem of stability in the air is a still more difficult one, if not, indeed, impossible of solution, as we might learn by the hint which nature gives, all birds being of the "heavier than air" type.

Man, however, has not been deterred from trying it, and has had absurd experiences in consequence. More than a century ago balloon ascensions began and they still continue and it cannot be said that in all these years, and with the modern dirigible before us, much has been accomplished toward the attainment of the impossible in this direction.

The balloon ascensions with which the last century made us familiar were practically all alike. There was the gas bag and the helpless mortal in the basket below it. There would be too much gas to begin with and lots of ballast. Starting with levity sufficient to carry the balloon rapidly upward, so that it would clear all terrestrial obstructions, it would continue to rise beyond the desirable limit of flotation because the air in the bag expands correspondingly with the reduced atmospheric pressure outside of it. If the balloon was full to begin with some of the gas would be forced out of the neck, sometimes asphyxiating the aëronaut. Normally, however, the correct practice would be to let out some of the gas, continuing this until the ascent was stopped. By the time that it could be ascertained that the balloon had ceased to ascend it would really be descending with more or less rapidity and to check the descent ballast would have to be thrown out, this operation also being carried to excess before the results of the action could be determined. Then it would be let out more gas, then throw out more ballast and so on as long as the game could be kept up, the last result being always to come ignominiously to earth upon any spot which the shifting winds might determine, and never to be hopelessly lost in the sky. This certainty of coming to earth in the end has doubtless saved many more or less valuable lives.

While these ups and downs of the balloon were going on other agencies would have their persistent effects. There would be constant changes of temperature, and consequently of the volume and levity of the gas, from the shining of the sun alternating with its obscuration from passing through different currents and strata of air. Sometimes the vast surface of the balloon would be dry and sometimes it would be heavily laden with moisture or actually wet with rain or even laden with accumulations of ice or snow, and then there would be more or less leakage or the interchange of air and gas continuous over the entire surface.

The dirigible balloon is still a balloon and subject to most of these balloon conditions and incidents. It is entirely balloon and only slightly a "dirigible." It must wait upon the fickle winds and can never oppose them. Under conditions the most favorable and seldom concurring it cannot at the best attain the speed of land conveyances. Of what possible use can it ever be except in some unforeseeable contingencies of warfare? For gambling purposes it would seem to be the ideal instrument, it involving so many elements of absolute uncertainty which can be neither predicted nor controlled.

While there are so many still scheming for perpetual motion, the balloonists, dirigible or otherwise, are not to be wondered at, but they would seem to be of the same type of visionaries, and suggest similar consideration and treatment.

The balloonist John LaMountain more than fifty years ago had a theory of an easterly air current which should carry him to Europe. He landed in the dense woods of the far northern Canadian wilderness, and he nearly starved to death before he worked his way out. Poor André started for the Pole, upon what theory nobody knows, and where he landed also nobody knows. At the present writing there is talk of flight to Europe by dirigible. While there is a law against suicide why should not such an attempt be preventable, at least until a flight of equal extent has been made over the land?

[The above article was written and presented before the start of the Wellman trip.—Ed.]—*American Machinist.*

Owing to the excessive humidity on the Canal Zone, good housekeepers there burn an incandescent lamp inside their pianos at all times to prevent the wires from rusting.

COMPRESSED AIR EFFICIENCIES

BY SNOWDEN B. REDFIELD.

It is fairly well known that the energy transformation in the use of compressed air is not high but the fact that it "does things," some of them better than by any other means and some which are not done by any other means at all, makes the matter of fuel economy of secondary importance. No apology is needed for the use of compressed air to-day.

That this matter of the fuel economy is not well understood is evidenced by the repeated appearance of propositions to develop the power of a water fall in the form of compressed air and transmit this through pipes to some distant point where its energy, like that of electricity, is supposed to be turned back again into work.

Such power-transmission propositions as this are utterly absurd because the losses in the compression and expansion of the air reduce the power efficiency to too low a point. These losses are not losses of pressure by friction, nor air by leakage, but simply losses due to heating and cooling.

It is not a difficult matter to prove that all of the work of compression goes into heat and is lost in pipe-line radiation. All of the work performed at the far end comes from the intrinsic heat originally in the air and the economy obtained depends entirely upon how the air is used. The actual cold compressed air traveling in the pipe does not at all represent the energy put into it by the compressor, as this has all been lost in radiation and the only answer to the question first expounded, is: "Nothing."

However, it is known that the air does work and this may be compared to the compressor work (although they have no direct relation) and in this way an "efficiency" may be stated.

As examples of machines using air with little or no expansion, rock drills and pneumatic tools may be cited and some interesting figures as to the efficiency of the power transformation, are given by the accompanying diagrams.

While actually indicating the drill or tool cylinder would be difficult, some rough idea of the indicated horsepower developed within it may be obtained by a little figuring, together with some judicious guessing.

Indicator diagrams of such machines would theoretically be rectangles, but wire drawing and cushioning effects of the valve mechanism would considerably modify this. It may be assumed then, reasoning from such a thing as a steam-pump cylinder, without cutoff, that the diagram factor will be about 80 per cent. In other words the actual mean effective pressure will be about 80 per cent. of what the theoretical rectangular diagram would give.

On this basis it is determined that a standard rock drill having a 3-inch diameter cylinder will develop about 6.2 indicated horsepower with 100 pounds at the throttle, this decreasing with the pressure supplied, down to about 3.7 indicated horsepower, with only 60 pounds pressure.

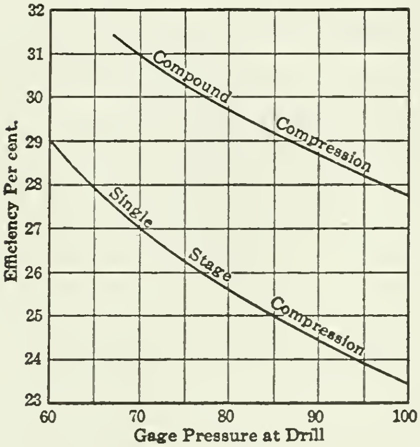


Fig. 1. Probable Efficiency Referred to Air End of Compressor

A 3-inch rock drill will require about 138 cubic feet of free air per minute with 100 pounds pressure at the throttle; this decreasing to 90 cubic feet, with only 60 pounds pressure.

Knowing the quantity of air and the pressure, the compressor horsepower is easily calculated.

Thus, allowing 10 pounds pressure drop in the pipe, a 3-inch rock drill will require 29.8 indicated horsepower in the steam cylinders of the compressor with 100 pounds pressure and single-stage compression, or 25.2 indicated horse-power with compound compression. These figures reduce as the pressure used is reduced, but this, of course, reduces the work done by the tool.

Comparing the probable indicated horsepower developed inside the drill cylinder with the actual compressor power required to furnish the air, gives the probable efficiencies shown by the chart. These efficiencies are referred to both the air and steam cylinders of the compressor, so as to give a basis for calculations for various methods of driving the compressor. They include 10 pounds pressure drop in the pipe line.

Referred to the air end of the compressor, it may be seen that with single-stage compression and 100 pounds pressure, about 23.5 per cent. efficiency is obtained, increasing to about 29 per cent. with the low pressure of 60 pounds. Compound air compression brings these figures up to 27.8 per cent. with 100 pounds and 31 per cent. with 70 pounds.

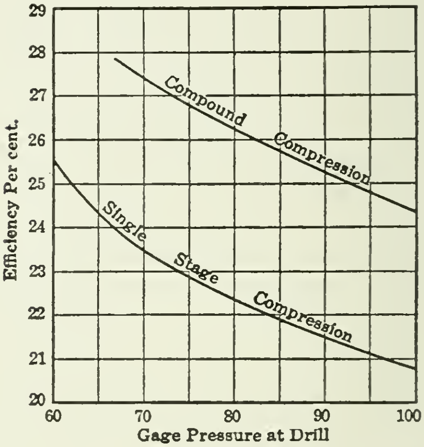


Fig. 2. Probable Efficiency Referred to Steam End of Compressor

Referred to the steam end, allowing 88 per cent. mechanical efficiency between the steam and air ends of the compressor, single-stage compression give a little less than 21 per cent. efficiency with 100 pounds and about 25.5 per cent. with 60 pounds air pressure. Compounding the air cylinders of the compressor increases these figures to about 24.5 per cent. with 100 pounds and almost 27½ per cent. with 70 pounds air pressure.

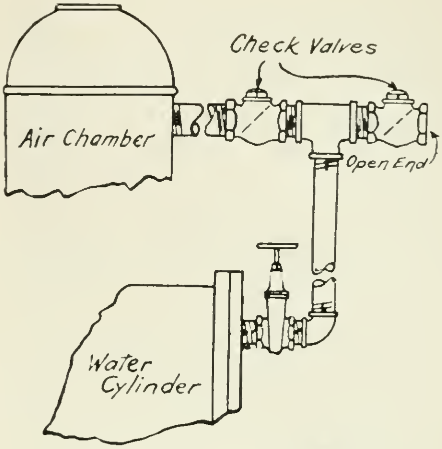
While these figures for efficiency have been determined for rock drills in particular, they apply equally well to almost any machine using compressed air without expansion. It must, however, be remembered that the figures are based upon indicated horsepower only, both in the drill and the compressor. This is because of the impracticability of measuring the "brake horsepower" of the drill. If, however, brake horsepower efficiency is required, these figures for efficiencies of indicated horsepowers can be multiplied by the mechanical efficiency of the device using the air, say 90 per cent. or 80 per cent., as the case may be.

It is to be noted that the higher efficiencies are obtained with the lower pressures. This is because there is less loss by heating the air during compression, and therefore it is advisable to use pressures as low as is consistent with the size and weight of the machine required to do a given amount of work.

RESPONSIBILITY OF THE AIR CHAMBER

At a meeting of the New England Water Works Association the cause and cure of vibration or hammering in water mains at considerable distances from the pumps came under discussion.

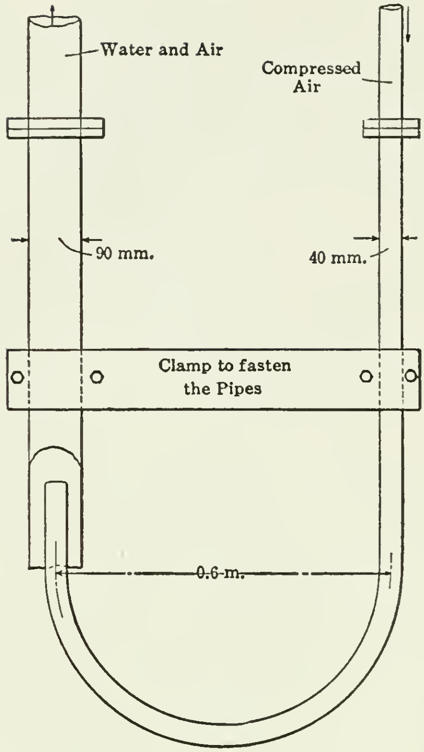
A letter from Houlton, Maine, stated that the supply there was pumped by a triple geared pump with rawhide pinions, having a capacity of 1,000 gallons per minute. Although the valves were kept in good order, residences located on the two 10-inch pumping mains within 2,000 feet from the pumping stations were troubled by vibrations which sounded like the pump gears. This experience was found to have been more or less closely paralleled at a number of other places, and various methods had been adopted as remedies. One conclusion most commonly reached was that this vibration or hammering was caused by a lack of air in the air chamber, while others attributed it to air in the mains or in the water cylinders of the pump. One pump manufacturer stated that he had had considerable trouble with the transmission through the mains of the noise of the gears where the pump was direct connected to the motor, which they had overcome by belt connections.



AIR SUPPLY FOR AIR CHAMBER.

An extreme case was cited as existing at Orona, Maine, where the pump is run by an electric motor. In this case there is a pounding on the lines so great that some of the consumers are kept awake at night by it and a number of copper boilers have been burst although tested to 200 pounds pressure, whereas the water pressure is under 100 pounds. At Greenfield, Mass., a gauge was placed on the air chamber to indicate when this was full of water, which sometimes occurred about an hour after it had been filled with air. In order to keep air in the air chamber the water end of the pump cylinder was connected with the air chamber by piping on which were placed a gate valve and two check valves, as shown in the accompanying sketch. When the pump is running, if the gate valve near the water cylinder of the pump be opened, as the pump makes a suction stroke it takes in air through the open-end check valve, and on the return stroke this check valve is closed and the air is forced through the other check valve into the air chamber of the pump. A little water finds its way into the vertical pipe of this connection and travels up and down with each stroke of the pump, acting as a plunger. The gate valve opening is so regulated that a very small amount of air is taken in at each stroke; not enough to be drawn down into the water cylinder. At Hingham, Mass., likewise the air chamber was found to fill with water, and there the air was replaced by connecting the chamber by a pipe with the compressed air starting outfit which formed a part of the gas-engine plant.

Russian lineal measure is as follows: 1 totchka equals 0.01 inch; 1 liniia, 0.1 in.; 1 vershok, 1.75 in.; 1 archine, 2 ft. 4 in.; 1 sagene, 7 ft.; 1 verst, 0.66287 mile. Measures of area are 1 square sagene, 49 sq. ft.; 1 dessiatina, 2.6997245 acres; 1 square verst, 0.43940829 square mile.



THE AIR LIFT IN A MINE SHAFT

A correspondent of the *Engineering and Mining Journal* thus describes the arrangement employed for the unwatering of a mine shaft in France. We add a few of the English equivalents of the French measures.

"A simple air lift can be quickly set up to unwater mine shafts. The accompanying sketch shows the arrangement of the piping. In the mine where it was used 40-mm. (1.5 in) and 90-mm. (3.5 in) pipes were at hand and, as the necessity of unwatering a certain shaft on the property was urgent, no time was spent in an effort to improve the efficiency of the appliance by tapering the ends of the pipes. Air was delivered at an effective pressure of 65 lb. per sq. in.; the vertical length of the 90-mm. water pipe was 40 m. (131 ft.), and its horizontal length 300 m. (984 ft.). The results were as follows: With a submergence of 30 (98 ft) to 35 (116 ft.) m. and a lift varying up to 5 m. (16 ft.) the output was over 200 liters (53 gal.) per min.; with a submergence of 14 m. and lift of 21 m. the output was 50 liters, and with a submergence of 11 m. and a lift of 24 m., it was only 30 liters. The output decreases, therefore, as the height which the water must be lifted increases.

"Although the efficiency of the system is not high, it presents valuable advantages for emergency use, as it can be quickly installed, does not require any attention, oiling nor, as does a pump, adjustment for every 7- to 8-m. variation of the head under which it is operating. In the case of a deep shaft this appliance might be used to assist the sinking pump, which would then require to be lowered only for 25- or 30-m. reduction of the water level."

It is rather queer that this writer did not use the metric figures for the air pressure the same as for all the rest of it.

BALLOON GAS

Balloon gas is the more valuable as its specific gravity becomes less. The gas for the recent Indianapolis balloon race had a gravity of 0.38 (standard conditions). Dr. Oechelhaeuser, general manager of the Dessau (Germany) gas works, says that German coal gas has a gravity ranging from 0.36 to 0.53 or an average of 0.41, while he has made balloon gas at Dessau having a specific gravity of 0.225 to 0.3 (average 0.27), air equaling unity. This gas is obtained by subjecting coal gas to a high temperature in either a horizontal or a vertical retort, which reduces the methane in his coal gas from 24.7 to 6.9 volume per cent. and increases the hydrogen from 59.6 to 80.7. The coal gas is subjected to a temperature of over 1,200 deg. C. by passing slowly through retorts filled with coke to increase the heating surface; a 10 ft. retort converting about 353 cu. ft. per hour at a cost of 12.5 cents per thousand for firing, or a total of 21 cents, but as the volume increases 20 per cent., this becomes 17 cents, although other charges will bring the extra cost up to 20 cents. The gas is air-cooled after coming from the retort, the dust filtered out, run through an oxide purifier and into a holder. He says that a balloon holding from 42,360 to 44,480 cu. ft. weighs with net, basket, charts, anchor, rope, etc., about 865 pounds and carries three persons weighing 620 lbs., not counting provisions or blankets, also 18 sand bags weighing 44 lbs. each or 440 lbs. of ballast, a total of 1,925 lbs. to lift. If the balloon can be filled with a

0.27 gravity gas instead of say a 0.37 gravity gas it will lift more to the extent of the difference or 10 per cent. of the air displaced, if of 4,300 cu. ft., say about 326 lbs., which will permit of so much more ballast being carried, and that is a big item in a balloon race.—*Progressive Age.*

COMPRESSOR COMPUTATIONS FOR A MINE PLANT

Two students of the Colorado School of Mines, Mr. J. W. Whitehurst and Mr. W. P. Cory, Class of 1910, prepared as a graduating thesis a design for a complete mine plant. The thesis was also prepared in competition for a prize offered by the Mining and Scientific Press, of San Francisco, which prize it secured.

The problem presented was to design and lay out a plant and select machinery and equipment for a mine operated through a 1,000 ft. vertical shaft. The altitude was approximately 10,500 ft. above sea level. The excessive cost of fuel at the mine favored an electrical installation, current to be bought from an independent company. Several other details were specified, but as we have to do here only with the compressed air, these are not given. What follows is from the thesis above mentioned.

It is proposed to use compressed air for drilling during a period of 16 hours, two 8-hour shifts, loading and shooting to be done during the remaining shift. Assuming that a 2¼ in. piston drill will break 10 tons of rock in an 8 hr. shift, it is found that the approximate number of drills required will be as follows: Rock to be broken per 16 hours=225 tons; capacity of one 2¼ in. drill for 16 hours=20 tons; number of 2¼ in. drills necessary, 11.25. These drills are to break all the rock to be hoisted in the mine; the waste broken by drills doing development to be used to fill open stopes. The 2¼ in. drills are equivalent to 68 per cent. of 3 in. drills, and hammer drills to 36 per cent. of 3 in. drills. These two constants are based on the relative air consumption of the drills. The drills cannot be operated continuously, due to loss of time in setting up and changing steel. Hammer drills require scarcely any time to set up and change steel, and therefore this consideration is not necessary. With the equivalent of a total of 8.3 three-inch drills in operation at one time, each requiring 125 cu. ft. of free air per minute at a pressure of 90 lb., a total of 1038 cu. ft. of free air (62° F. and 14.75 lb. pressure per square inch) is required at the drills; the operating pressure at the drills to be 90 lb., gage.

The barometer at the mine reads approximately 20.39 in., equivalent to 10 lb. per square inch absolute pressure. This may be corrected for altitude as follows:

$$\frac{14.7 \times 1038}{10} = 1525 \text{ cu. ft.}$$

To estimate the air required, allow 10 per cent. loss in transmission through the pipes, then there will be required:

$$\frac{1525}{.90} = 1694 \text{ cu. ft.}$$

under atmospheric conditions at the discharge valves of the compressor. Allowing a loss of 5 per cent. for imperfect valve action and heating of incoming air, there will be required taken into the compressor per minute:

$$\frac{1694}{.95} = 1783 \text{ cu. ft.}$$

under atmospheric conditions. To allow for loss of pressure in transmission it is considered that the final discharge pressure at the compressor is 95 lb. gage. It is better therefore to select a two-stage machine. The absolute discharge pressure of the low pressure cylinder should be:

$$\sqrt{10 \times 105} = 32.4$$

absolute. It is assumed in this computation that there is complete cooling between the stages and equal distribution of the work.

Assuming 2 per cent. clearance, the factor of clearance becomes,

$$F = 1 - \frac{2}{100} \left|\frac{32.2}{10}\right|^{0.712} + 0.02 = 0.974$$

The factor of clearance is equivalent to the ratio of the displacement of the piston to the total value of the cylinder. Then the displacement of the low-pressure cylinder is:

$$\frac{1785}{0.974} = 1832 \text{ cu. ft. per minute.}$$

Assume a 24-in. stroke with the compressor running at 150 r.p.m. Then the displacement per stroke of low-pressure cylinder is:

$$\frac{1832}{2 \times 150} = 6.106 \text{ cu. ft.}$$

and $\frac{6.106}{2} = 3.053$ sq. ft. = area low pressure cylinder. Diameter of low-pressure cylinder, approximately 24 in., and 13.4 in. diam. of high-pressure cylinder; indicated horse-power of air cylinders is 218. Allowing 77 per cent. for combined efficiency of motor and compressor,

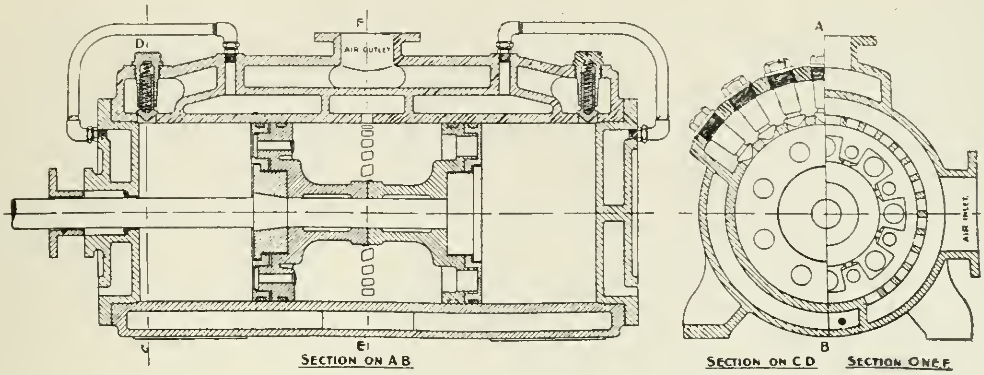
$$\frac{218}{77} = 283 \text{ hp. required for motor.}$$

From the above data a belt-driven 2-stage compressor has been selected. The compressor is to be driven by a 440-volt, 60-cycle, 3-phase, 285-hp. induction motor running at 600 r.p.m. with a driving pulley 30 in. diam. The belt is to be extra heavy double-ply leather, 21 in. wide. This compressor is rated at 1885 cu. ft. free air per minute at 95-lb. gauge pressure, which corresponds closely with calculations.

Air should be supplied to the low-pressure cylinder at as low a temperature as possible to secure greatest efficiency. There is an increase in volumetric efficiency of 1 per cent. for every 5°F. reduction in temperature of entering air, below that of the engine room. To accomplish this, a wood conduit 2 by 2 ft. is led from the inlet valves of the compressor to a point under the eaves on the north side of the building. Receivers are not so much for the purpose of storing the air, thus acting as a reservoir of energy, as to partly cool the air and free it from moisture before entering the main pipe-line, and to reduce the pulsating effect produced by the operation of the compressor. With these objects in view a 36-in. by 8-ft. upright receiver is to be erected. A second 30-in. by 5-ft. receiver is to be placed at the seventh level station to supply the seventh and eighth levels by means of suitable and separate 2-in. pipe-lines. A third 30-in. by 5-ft. receiver is to be placed near the pump station on the tenth level, supplying the ninth and tenth levels through 2-in. pipe-lines. The pipe, from compressor to receiver, is placed in a conduit, one foot square, in the cement floor; the floor at top of the conduit is recessed for receiving a cast-iron cover. From receiver to shaft the pipe is buried 18 in. underground. In the shaft the pipe is supported every 10 ft. From compressor to seventh level the pipe is 5-in. inside diameter; at this point a 4-in. branch line runs to the receiver and the main line, reduced to 4-in., extends to receiver on tenth level. All piping is to be standard weight, lap-welded mild steel, with flanges screwed on and supplied with suitable rubber gaskets.

PRACTICAL PIECEWORK

There is no system like piecework with the class of men we are getting to-day. You get up here and say you have 200 machinists. What do you do with them? You are spending a lot of money in looking after those machinists, but when you put the men on piecework you do not have to do so. We have an assistant general foreman who times all new operations. The men get so that the minute they get hold of a new job they look him up and say: "Come and time the new job that I have." We have never cut the price in Cleveland with the exception of where the company has spent money in buying new tools. We endeavor to be fair to the men and fair to the company. We do not work piecework on a job until the piecework schedule has been signed by five men—the assitsant general foreman, the general foreman, the master mechanic, the shop specialist, and the mechanical superintendent. And the price cannot be changed without the consent of the five people that signed the cards. I do not know of a place where the price has been cut for three years.—*J. A. Boyden at the General Foremen's Convention.*



A NOVEL PISTON INLET.

AN AIR COMPRESSOR CYLINDER

The cut on this page shows sections of an air compressor cylinder as built by John Wood & Sons, Ltd., Wigan, England. The unusual feature is in the system of air intake. It will be seen that the cylinder is abnormally long for the piston stroke, and that the piston faces are widely separated, or in fact comprise two pistons fixed upon the same rod. There is an intake air passage surrounding the middle of the cylinder with numerous radial openings direct into the cylinder. The face of each piston carries a large annular valve of slight movement, covering liberal openings through the piston. This valve is quite heavy and is provided with a regular packing ring, which fits the periphery of the cylinder, causing friction which operates the valve, opening or closing the piston passages upon each reversal of the stroke. This arrangement permits most complete water jacketing.

DESPERATE PLIGHT AND DARING RESCUE OF A DIVER

One of the horrifying experiences which are not infrequently the lot of the submarine diver, came recently to Frank H. Nystrom, working in a trench in which a large gas main was to be laid in the bottom of the Harlem River, near Second Avenue, New York City. He was in the regular diver's dress, working under a pressure of probably 15 pounds. His work at the time was the feeding of the loosened material to an 8 in. pipe of a suction dredge. Some obstruction occurred and, while feeling about to find the trouble, the upper crust of the trench suddenly caved in, burying him to the waist, but, worst of all, one or two big stones pinching his foot and holding him fast. The details of his experience follow, as told to a reporter of the *New York Times*:

"I realized it would be folly to signal my comrades above to haul me aloft. If they could have done this they would have torn my leg from my body. But at last I took a chance and pulled the emergency cord, sending up a signal of danger and distress. A response came swiftly that help was coming.

"That made me feel better. I believed it would not be a hard matter for companion divers to dig me out, and lift the rocks from my foot. Presently I distinguished against the black fog of the river the faint glimmer of the lamp of a diver's helmet. I watched him eagerly as he made his way toward me. It seemed to me he came painfully slow. He had in his hand a pick and shovel.

"The diver paused near me, and seemed to be taking in my situation. He did not seem exactly to like the look of things. Finally he came a little closer, and began to dig away at the sand in the trench. But he didn't do any good. As fast as he dug out the sand it was swept back into the trench by the water.

"There is a way that divers have under water of communicating with each other. It is by pressing together the heads of their copper helmets. Then their voices can be clearly distinguished. I extended my arm toward my companion in the manner of divers wanting to have verbal communication, but he recoiled at my touch and backed away from me.

I made beseeching gestures for him to come near me. He stood viewing me at a safe distance.

"When I saw it was useless to try to induce him to return, I sent up another distress and danger signal, more urgent than the first. Presently another diver appeared. Like the first diver, though, he was afraid to venture very near me. I could see that they were afraid I would grab them in the iron grip of a desperate man, and that they were afraid of sharing my fate in the trench. I called, cajoled, and pleaded to them in the language of the submarine diver, but they refused to come near me.

"Then I sent up another call for assistance, and a third diver was sent down. He, too, like the others, would have nothing to do with me.

"The sand and the pebbles that enveloped my body from the waist down, squeezed me tight, and the blood in my temples was throbbing until I thought my head would burst. I had been in an upright position for what seemed an eternity, and my strength was rapidly leaving me. The tide gurgled by me, and between the pressure of clay against my body and the pressure of water above me I thought I must soon collapse.

"And all the while, grimly watching me, but afraid to touch me, stood my fellow-divers.

"How long I stood this way I do not know. But at last another diver appeared on the scene. I found out afterward it was John Anderson, the foreman. He came to me with none of the timidity that marked the other divers. He walked right up to me, and when I started to lay my hand on his shoulder to signify I wanted to talk to him, he did not draw away as if he were afraid I would drag him down.

"We put our copper helmets together.

"'For God's sake.' I shouted with all the strength left in me, 'help me to get out of this.'

"I told him if he would get a knife and cut my diving shoe off my foot I thought he could pull me out. The knife was soon forthcoming. He dug away the sand and pebbles and cut the strap of the boot. Then he gripped me around the waist and pulled me out of the grave that had held me prisoner for four long hours. And now I am home again."

VARIOUS ICE FORMATIONS

Dr. H. T. Barnes, professor of physics at McGill University, Montreal, has peculiar facilities for the study of ice, on account of the close touch with the St. Lawrence. The subject is of much importance in the neighborhood of Montreal on account of the serious floods which occur, caused chiefly by the ice. In a paper before the New England Water Works Association, Dr. Barnes gave interesting information derived from his investigations.

SURFACE ICE.

In a lake or river not flowing with sufficient rapidity to produce serious eddies, with the advent of cold weather and the approach of the water temperature to 32 degrees Fahr. there is a tendency to form ice. Depending to a large extent on the vagaries of climate or direction of wind, the ice forms first along the shores, and gradually extends out on all sides. Several conditions must hold before the surface can be entirely covered. The water must be at or very near the freezing point, the air temperature must be at or below the freezing point and the wind must be practically zero in order that no ripples be produced.

Atmospheric humidity determines very largely the growth of the first ice cover. A dry wind will produce rapid evaporation and a consequent rapid absorption of heat. In a cold atmosphere the air over the water is warmed and is in consequence capable of absorbing more moisture than it can hold when blown away to colder parts. Hence the characteristic steaming of open water or thin ice which is observed when the atmosphere is in the neighborhood of 10 degrees Fahr. The exact temperature of the water also plays an important part in the formation and growth of surface ice. With water exactly at 32 degrees Fahr. ice will thicken indefinitely as long as the air temperature is below the freezing point, but it seldom happens sthat the water is exactly at 32 degrees Fahr. under an ice sheet. It is usually 0.01 degrees or 0.02 degrees above freezing and the influence of this is to produce a limiting thickness to which the ice will grow, or in other words a balance is finally produced between the heat carried away by conduction through the ice and heat supplied by convection streams of water slightly warmer than 32 degrees Fahr. which bathe the under surface of the ice sheet. If the water is higher in temperature, due to bottom streams being deflected upwards by shoals or to warm springs, then no surface ice may form at all.

The position of the first ice crystals is along the surface of the water, but as soon as formation proceeds as a result of conduction of heat through the ice then the ice crystals are all orientated with their principal axes at right angles to the water surface. It has been indicated by previous experiment that an ice crystal conducts heat best in the direction of the principal axis and the fact that all such crystals turned so as to transmit the heat of the water most readily indicates that this is so. The difference between conduction ice and conglomerate ice, that is, ice formed by the freezing together of irregular masses, is very great when considered with reference to their power of disintegration. Salt water ice is a notable example of this, and the masses of such ice not being regular in crystalline structure take a very long time to melt. There has been very little, if any, scientific work done in studying the rate of growth of surface ice and the data available are practically useless.

The main factor in surface formation is the conduction effect, but the rate of growth is affected by convection currents in the water, humidity of the air, which influences the evaporation, and the velocity of the air currents over the ice. Radiation is a small factor which comes into the calculations, both a gain of heat from the sky and loss of heat from the ice surface to the air. Accumulations of snow on the surface produce an uncertain factor, but nevertheless an important one which may be corrected for when the depth of snow is known.

FRAZIL ICE.

Wherever a river flows too swiftly for surface ice to form into a sheet it remains disintegrated in small crystals and is carried down by the current. On account of the smallness of the crystals they have little buoyancy and are therefore easily swept under by currents. The amount of frazil, as such ice is called, (*frawzeel,* if you please) that is formed depends on the mean air temperature, but more on the degree of agitation of the water. Thus in a rapid, where the water is intimately mixed with the cold air, a great deal of frazil is produced, which becomes troublesome at times and is the cause of winter and spring floods on many rivers. It is swept by currents under the surface ice which is formed in the quieter parts of the river. Then it floats up to the underside of the surface sheet and freezes, building down great hanging dams that become as impervious to water as so much rock. The natural river channel is restricted and in consequence the winter level is much higher than in summer.

Although this ice is formed most rapidly on the surface it appears also throughout the body of the river when the water is supercooled. The supercooling is never more than a few thousandths of a degree, but notwithstanding this produces great physical effects. It is during such a time that the ice becomes adhesive, agglomerated and produces trouble to the operators of water powers. The strength and tenacity of the frazil so long as the temperature remains below the freezing point is enormous. It wants but the very smallest change of temperature in the water, however, to make it soft and sponge-like and easily disintegrated. The sun is the most powerful agent in imparting the necessary small fraction of temperature to the water to relieve ice troubles. Thus water wheels which have been securely cemented during the night are soon running again the next day when the sun comes out. Artificial methods of heating have been developed which have proved remarkably successful.

ANCHOR ICE.

The formation of ice on the bed of a river which is not frozen over has been observed for many years. In America it goes by the name of anchor ice and in Europe as bottom or ground ice. There has been much discussion over the cause of its formation. It has now been widely accepted that it grows on the surface of objects immersed in water which is slightly supercooled and flowing too fast to freeze over. On clear cold nights it is found growing more rapidly than on cloudy ones and it is observed to form on dark rocks faster than on light colored ones. Terrestrial radiation is therefore responsible for much of the ice, and in addition vast quantities of frazil crystals are frozen to the bottom ice after having been carried down by currents. With the water above the freezing point no anchor ice can form. It has never been observed to grow on the bottom under surface ice. Whenever it has formed previous to surface ice it is dislodged as soon as the cover forms and rises up to become attached to the under side of the surface sheet.

The sun has a powerful influence in preventing anchor ice formation and in melting it off when once it has formed. It is a well-known sight along the St. Lawrence on a clear cold morning in winter to find great masses of ice rising from the bottom as soon as the sun's rays can penetrate into the water. These masses have been attached to the ground and by growing in size have exerted greater and greater buoyant force on the rocks. Some of them come up bringing masses of rock with them purely by their own force. Boatmen on the river are very careful not to go out when the ice is rising for fear of being surrounded or upset by masses of this ice rising under the boats.

PISTON OR HAMMER DRILLS?

By James E. Harding.

The application of hammer drills to flat work, compared to the length of time that power drills have been used for such work, is of recent date. There is but slight difference between the two types of machines when considering the arrangement of valves, etc., the main difference being in the way the power is applied to the steel. In the piston machine the steel is held rigidly in the chuck and the blow is struck by the movement of the entire steel, chuck and piston. In the hammer type of drill the steel is held loosely in the chuck and does not move back and forth, but the blow is struck directly upon the shank end of the steel. Right here comes a point in favor of the hammer drill. It will be readily seen that a large amount of power is lost by the friction of the steel moving back and forth in the hole. Also, in drilling holes with a piston, whether up or down holes, much friction develops from the dust in the one and the mud in the other.

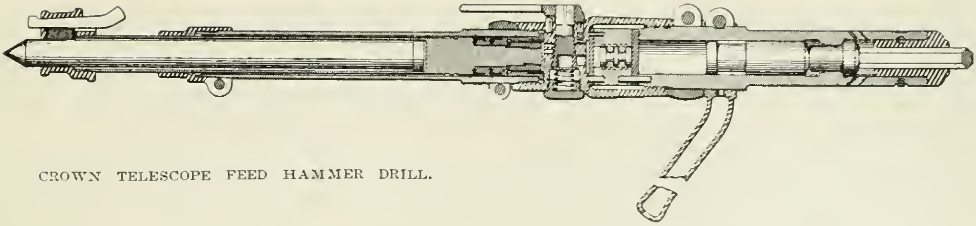
In setting up a column or bar for the two machines, much more care has' to be used in case of the piston machines on account of their back kick. A set-up oftentimes that would be kicked down in starting one hole with a piston machine will stand for a round with a hammer drill, which has a big vibration but practically no back kick.

After the set-up is made a drill runner will find that there is much difference in the labor of starting holes. Every man who has run a piston machine knows the pleasure of holding a dancing steel against a slanting surface, with either a chuck wrench or another steel, while a hole is being collared. This difficulty is practically eliminated in a hammer drill, owing to the fact that the steel is not moving and but little difficulty is found in starting a hole on a badly slanting surface.

Then, too, after the hole is collared, the rapidity of the running down is far greater with a hammer machine than a piston. At a contest in Victor, Colo., held July 4, 1910, a hammer drill went through 16 feet and 6 inches in 15 minutes, and, while records are not at hand for piston drills, I very much doubt if there is a piston machine made that would have drilled 4 ft. in the same rock in the same time. The rock was hard Pikes Peak granite, full of biotite mica and orthoclase feldspar.

Practically all the hammer machines made are equipped with hollow steel, through which is introduced into the hole at the bottom, where the cutting is going on, to expel the cuttings, either air or water or a mixture of the two. The use of water or air and water running through the steel seems to be the best, as in that case there is no dust, which has sent so many "hard rock" men to an untimely grave with "miners' consumption." Also this method of cleaning the hole keeps the steel up against clean rock at all times, and the force of the blow is not halted by the steel driving through 2 or 3 inches of thick mud. Perhaps the greatest advantage of this method of cleaning holes comes in drilling "back holes." I have seen more perfectly good time and profanity wasted in twisting or kicking a stuck steel out of a mudded back hole than in almost any other one thing in mining.

The labor of running the different types of machines is not to be compared. I have a definite remembrance of running a machine in a mine in Cripple Creek, driving a crosscut through solid syenite, after which all other rock that I have ever tackled seems soft. In those shifts I do not remember of ever sending up less than 90 pieces of steel, and some days the count would run as high as 140. Now it is an assured fact that a



CROWN TELESCOPE FEED HAMMER DRILL.

chuck tender who has handled that number of pieces in a day will not feet a bit frisky at tally. The average chuck tender will use on an average of two minutes to the change, and in making the above number of changes in a shift it is not hard to see where much time has gone. Practically all the hammer machines use no chuck bolt, the steel being merely inserted in the chuck and given a half turn to catch the ratchet lugs on the shank. Changing steel involves not more than 30 seconds by a reasonably active man. Incidentally, not a single hard lift is involved, such as is required in setting a chuck nut home.

I have seen it demonstrated more than a dozen times that one man on a hammer machine can pull as much rock as two men on a piston machine, and both parties equally good runners. I, personally, know of one case, the El Paso mine of the Cripple district, where an accurate account was kept on flat work and the cost per lineal foot was 33⅓ per cent. less where hammer drills were used than it was where piston machines were used.

Of course all the argument is not in favor of hammer drills. The repair account of the two types of machine is greatly in favor of the piston type. As they are now constructed, the hammer type of machine is rather delicate, and, on the other hand, the piston machine will stand more rough usage and abuse at the hands of unskilled or careless and ignorant miners than any piece of machinery that I have ever seen. I also know of one case where the repair bill of a single hammer machine for a single month amounted to over $280, caused almost entirely by a poor runner. A much higher order of intelligence is required for a runner of hammer drills than of piston machines. One can crank a piston machine by the sound as well as by the feel, but a hammer drill is cranked practically by ear. It gives out a clear, high-keyed ring when running right, and if too close or too far away from the ground the key immediately changes.

An experienced runner on piston machines often gets into difficulty when he tries to run a hammer machine. I recall one instance that I know of in the Blue Bird mine at Cripple Creek. A latest model of hammer machine was running in the south side of one level and an old 2-in. piston machine was running in the north side. The runner of the hammer machine was an old piston man and the runner of the piston machine had had but very little experience in running machines of any sort. The piston machine more than doubled the hammer machine in footage and in the amount of muck broken, and also the piston machine runner had his round in generally an hour before the hammer machine man. So it shows that the ability of either one of the machines to break ground depends largely upon the man behind.

But, altogether, taking the two types of machine, by and large, considering the labor of operation, the expense of unkeep and the amount of ground broken, from the view-point both of a drill runner and an employer in an experience covering several years, I speak my word without an instant's hesitation in favor of the hammer type of machine.—*Mining Science.*

ENORMOUS AND NOVEL COMPRESSOR PLANT FOR THE RAND

The air distribution system being installed on the Rand, South Africa, will be unique, not only on account of its size, the largest in the world, the first installation alone comprising a plant of 40,000 horse power, but also in the type of compressors adopted. These are of the rotary type and will be the largest individual units ever built. The Rosherville station will accommodate four of these turbo-compressors, each of 4,000 h. p. capacity, and here the prime movers will be steam turbines. Six more turbo-compressors of the same output are to be installed at the Robinson Central Station, but in this case the compressors will be driven by electric motors at 300 r. p. m. Each unit is guaranteed to compress 590 cu. m. (20,835 cu.. ft.) of free air per minute, at an atmospheric pressure of 610 mm. (24 inches of mercury, corresponding to an altitude of about 5,800 feet) to a terminal pressure of 9 kg. per sq. cm. absolute (116 lbs., gage, at that elevation). The delivery temperature is not to exceed 85 deg. C. (185° Fahr.). The principal air mains leaving Rosherville Station have a diameter of 24 ins., and the diameters are tapered down to 9 ins. on approaching the consumers' properties. The average velocity in the mains will be about 35 ft. a second. The pipes are of lap-welded steel, with a special joint which has been designed to prevent leakage. The size of the pipes is calculated on a basis of an average drop of about 5 lbs. in the pressure. The total length of pipes installed at present amounts to 19 miles, and the lay-out is so designed as to permit any extensions in the future and the formation of ring circuits for the area supplied.

METERING THE AIR.

In accordance with the contract entered into with the mines, the meters for measuring the compressed air had to be so arranged as to register the energy contained in the compressed air in "air units." In deciding upon the type of air meter the following alternative designs were available: (1) Displacemennt meters, (2) fan meters, (3) meters involving the impact of the moving air upon the plate or surface, (4) meters involving a Pitot tube, (5) meters designed on the Venturi principle. The adoption of the displacement meter was out of the question on account of high initial cost and the large difference of pressure required for operation. The fan meter was undesirable on account of the comparatively short range over which the revolution of the fan is proportional to the velocity of the air, and for other reasons. The impact type of meter was regarded as unsuitable on account of its small range. The use of the Pitot type was thought undesirable partly because the relation between the maximum and the mean velocity in the pipe varies with the rate of flow and the slight irregularities in the surface of the tube which disturb the even spacing of the stream lines. but mainly because of the very small difference of pressure due to the Pitot head which is available for effecting the measurement of the velocity. Meters designed on the Venturi principle are considered to have many advantages for the requirements of the case, among them being the following: The law of flow through the Venturi tubes is precisely known, and the Venturi heads obtainable with 1-10th of a lb. per square inch drop of pressure across the meter allow the flow to be exactly measured with one tube over a range of about 1 to 30. The meter registers the logarithmic functions of the Venturi head, the pressure, and the temperature independently. The addition of these various logarithmic functions is effected by means of a double differential gear. The measurement of the Venturi head is taken by the movement of a light inverted bell, immersed in an oil seal, the throat pressure acting on the underside of the bell and the main pressure acting on the outside. An increase of flow thus causes the bell to sink. The device for measuring the pressure consists of an ordinary Bourdon tube such as is used in pressure gauges; four such tubes are arranged to move the pressure cam in order to ensure an ample margin of power. For the measurement of temperature a small steel bulb containing liquid anhydrous ammonia is placed in the air main, and is connected by means of a flexible steel tube to a Bourdon tube in the recorder. The error introduced into the readings by the change of temperature, if not registered, would be about 1 per cent. for every 10 degrees change. The error introduced by not recording the change of pressure would be 1 per cent. for every 1 lb. per square inch change in the pressure. It will be seen, therefore, that the automatic registration of the changes in pressure is very much more important that the registration of the changes in temperature.

Edison is reported to have said: "The earth has quite a bulk, but it slips through the ether with so little friction that your thumb in the right place could move it." But how far could you move it if you pushed all your life?

COMPRESSED AIR
MAGAZINE
EVERYTHING PNEUMATIC
Established 1896

W. L. SAUNDERS, - - - - - - Editor
FRANK RICHARDS, - - Managing Editor
F. C. IGLEHART, Jr., - - Business Manager
W. C. LAROS, - - - - - Circulation Manager

PUBLISHED BY THE
Compressed Air Magazine Company
Easton, Pa.

New York Office—Bowling Green Building.
London Office—114 Queen Victoria Street.

Subscription, including postage, United States and Mexico, $1.00 a year. Canada and abroad, $1.50 a year. Single copies, 10 cents.

Those who fail to receive papers promptly will please notify us at once.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors inventors and others interested in compressed air.

Entered as second-class matter at the Easton, Pa. Post Office.

Vol. XV. DECEMBER, 1910. No. 12

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THE ALWAYS READY AIR POWER HOIST

For industrial establishments of any considerable extent a supply of compressed air for general power purposes, that is for the numerous smaller and more scattered power requirements, may be said to have advanced its own status from at first that of a mere convenience to now an actual necessity, and the works which pretend to any standing or which boast any business enterprise and which have not a permanent and reliable supply of compressed air applied to various uses are the exception rather than the rule. Compressed air constantly proves itself an excellent servant for light, widely separated and occasional services, and it shows itself perhaps at its best when used for hoisting purposes. The direct acting single cylinder air hoist, for its instantaneous readiness and its quickness and precision of action, is without a rival in its special field, while the geared motor hoist gives a control of the rate of lowering and hoisting, and an absolute certainty of holding the load at any point and for any length of time, which cannot be surpassed.

In the employment of compressed air for the driving of continuously operated tools or machines there is one particular condition which is generally imperative. It is necessary to have a continuously running compressor, because it is not practicable to store the air in sufficient quantity to last for any length of time. With a compressor of a capacity adapted to its regular load, both production and consumption of the compressed air going on continuously and at an approximately equal rate, the compressor, with the air storage capacity usually provided, can only be said to be about a single minute ahead of whatever it furnishes the air to, so that if it should stop for a minute all the running machinery driven by it might be expected to be out of commission in the next minute.

This one minute of margin, however, constitutes a vast difference from and an advantage over the electric drive, with which there is not a single second of margin. The generator must never stop if what it drives is not to stop. If the generator stopped an electric hoist would be as inert as a watch without a mainspring. When we see a streetful of trolley cars stopped we know that the drive is dead at the power house. The wires will then not supply current to move a single car any more than to move all the cars on the line. When the generator is started again there must be current enough to move all the cars on the line, and this must be always kept ready for the work no matter how much the cars may be stopping and starting.

For the operating of air hoists, one or many, and whether direct acting or motor driven, the possibility of air storage, although, as said, it is limited, is still sufficient to give the air hoist an important economic advantage. It really takes very little—reckoned in horse powers—for any single operation of hoisting, and the time required for the hoisting is very small when compared with the intervals of rest between, so that a very small compressor running continuously may supply not only one but several air hoists, and without any excessive or expensive storage capacity. In shops where an air supply is maintained for operating pneumatic tools and for the numerous air operated devices now so common, especially in railroad ships, the consumption of air by the hoists is scarcely discoverable. To raise a ton five feet high in one minute requires only a half of a horse power, with liberal allowance for friction and other losses, and this half of a horse power may be furnished by a compressor of one-tenth of that capacity or less allowing it to work right along through the intervals generally occurring between the hoists, while electric power would have to be all there at the moment of hoisting.

We of course are not forgetting the electric traveling crane, but for the incidental hoisting which occurs in all the industries the air hoist has a field of its own which it is quite sure to continue to hold.

WORK OF THE BUREAU OF MINES*

The Bureau of Mines was created by Congress as the result of a demand coming not only from the mining industry, but also from the general public in different parts of the country. The chief purpose of the Bureau of Mines is the development of greater safety and efficiency in mining. It may be expressed in another way as "lessening the loss of life and the waste of resources" in connections with the operations of the American mining industry. Or, as expressed in a yet different way, its chief purpose is the "conservation of the lives of the miners and the mineral resources of the country."

If, in view of the fact that the Bureau has no means of enforcing and carrying out its recommendations, the question is raised as to how it can aid in the accomplishment of these purposes, it may be said in answer that the Bureau neither needs nor desires any authority, except that based upon an enlightened public opinion. The Bureau will endeavor to aid in carrying out these purposes by conducting investigations and inquiries into the best mining and treatment practices to be found in different mining countries, and into the fundamental chemical and physical problems that serve as a basis for more efficient metallurgical operations. It will thus endeavor to indicate how all branches of the industry may become both safer and less wasteful; but the Bureau will leave to other agencies the enforcement of new requirements, or even the adoption of its recommendations. It will publish the results of its investigations and inquiries in such form as to make them easily interpreted in daily mining practice in the United States.

The new Bureau will do everything it can do to encourage each State in the investigation of its own local mining problems, and in the proper inspection and supervision of the mines operating within its borders. It will do everything possible to help maintain and increase the influence and effectiveness of the State Mine Inspector. It will endeavor to co-operate with, but not to belittle or supplant, the work of the State. Similarly, it will do everything within its power to encourage private mining corporations to investigate their own local problems, and to properly inspect their own mining operations, with the view of lessening the loss of life and waste of resources. It will itself take up inquiries and investigations in which the National Government as such is a party at interest, and to those other problems in relation to the mining and treatment of our mineral resources that are general in their application, or national in their importance. The Bureau will in this way endeavor to minimize the responsibility of the Federal Government; and to minimize the contribution which the Federal Treasury may be called upon to make in behalf of a proper development of the mining industries. In the wise development of our two great foundation industries, agriculture, and mining, which are alike essential to the present and future welfare of the Nation, the Federal Government, the State, and the private individual or corporation each has its responsibility and its duty, which responsibility and duty no one of them should shirk.

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*From an address by J. A. Holmes, Director of the Bureau, at the session of the American Mining Congress, Los Angeles, California, September 28, 1919.

The work of the new Bureau should not diminish the work of the private mining engineer, but, on the other hand, should increase his work by pointing out to mine owners additional problems which he should be called upon to solve at the cost of the parties most interested. Such has been the result of the preliminary work conducted by the Technologic Branch of Geological Survey during the past few years, and a similar result should follow the work of the Bureau of Mines.

Every one responsible for the establishment of the Bureau of Mines realizes the fact that its first duty is to aid in lessening the loss of life in mining. Those associated with the work of the Bureau realize that the mine owners of this country are in full sympathy with this purpose, and that they stand ready to put into practice, as far as conditions will permit, every practicable recommendation and suggestion that the Bureau may have to make. On the other hand, the people of this country are beginning to realize that many of the methods practised and appliances used in other countries, where profits of mining, and especially of coal mining, are far greater than in the United States, can not easily be introduced into the United States, because their cost would exceed the profits of the industry here; as no industry can operate on a basis of financial loss. Nevertheless, progress is being made, as shown by the fact that the loss of life in the American mines has decreased more than 25 per cent. during the past two years.

The appeal of the new Bureau is therefore to every man connected with the mining industry in this country, to the mine worker, the inspector, and the mine owner alike, that he do everything that can in reason be done to safeguard the lives of the men who labor underground; to see that the disasters at Monongah, Darr, Marianna, and Cherry shall have no counterpart during the winter of 1910; and that the daily toll in the lives of miners from other causes, less impressive, but in the aggregate more destructive than these awful disasters, shall steadily diminish.

In the demand for the creation of this Bureau, the mine owners and mine workers alike have joined. Let no one of these suppose for one moment that with the establishment of the Bureau his work has ended; for in reality it has only just begun. It is only under the good advice of those most familiar with all branches of mining that wise leadership by the new Bureau can be properly developed; and the Director of the Bureau will welcome such advice.

In the competitive branches of the mining industry, such as coal mining, the lawmaker also must contribute by helping to improve the economic conditions which now hinder wise practice and development. All these agencies must co-operate if the mining industry as a whole is to reach that higher standard of safety and efficiency which should characterize this American industry, and to which we look forward with full hope of accomplishment. There are many difficulties in the way, and the path will not in all cases be plainly marked. There will be differences of opinion, both as to what should be done, and as to the mode of procedure. But the Director of the new Bureau wishes the members of the American Mining Congress, and mining men throughout the country, to know that their sugestions and advice will be welcome always, even if it cannot always be followed. He realizes that this Bureau is not his, but yours, and his highest aim will be to render a disinterested loyal service to the mining and metallurgical industry in all its branches, in all parts of this country.

PROGRESS ON THE BARGE CANAL

Rapid progress was made during the past year in constructing the New York State Barge Canal. At the end of 1909 76 per cent. of the total length had been placed under contract and it is expected that the whole of it will be let by April 1 next. The total length of the Barge Canal system, exclusive of the Niagara River, which is being improved by the federal government, and the Hudson river below Waterford, which it is anticipated the government will improve, is 433 miles. Of this amount at the end of 1909 314.2 miles were under contract at prices aggregating $54,138,329. In addition plans for 67.7 miles had been completed, plans for 9 miles more were over 75 per cent. finished and the plans for the remaining 20.5 miles were well under way. Of the 53 new locks 15 had been completed at the end of the year, with the exception of gates and operating machinery. By a year from next spring it is expected that the eight movable dams in the Mohawk River will be in operation and will be used to aid in the dredging of the channel, by retaining water for the floating of dredging machinery. The large fixed dam across the Mohawk River near Crescent will be finished during next summer, as will also the concrete dam impounding the waters of the upper Mohawk at Delta in a reservoir having a flooded area of 2,800 acres.

An important feature of the Barge Canal work is that it is being done within the original estimates. The estimates made in 1903 for construction on the portions of the canal now under contract amounted to $56,791,537, while the contract price for this work as revised by alterations was $54,138,329, or $2,653,208 within the original estimates.

CHARLES T. PORTER

I feel impelled to offer my word of tribute to the memory of Charles T. Porter. The rushing world had, in a way, swept past him. He belonged to the Nineteenth rather than to the Twentieth Century, and was no longer under the spot light. And yet he was undoubtedly one of the world's great engineers and had been especially an epoch maker in engineering progress.

Last year he was the fifth one to receive the John Fritz medal "for notable scientific or industrial achievement." This honor had been eminently well bestowed in each preceding case, and the latest recipient was in no way less entitled to it than any of his illustrious predecessors. The general up-to-date public perhaps knew his name somewhat less familiarly than it knew the others, but the engineering world knew him well, although few, after all, realized the magnitude of the world's indebtedness to him.

The formal award of the John Fritz medal in Mr. Porter's case was for his work in the development of the modern high-speed engine. He revolutionized steam engineering, and the later developments of the power house, and the special applications of steam in the rolling mill, in marine service, in the vast electric field, and practically wherever steam is economically employed for power development, were led up to and made possible and actual by him.

And all this came not as the result of a single happy thought or of one great invention, but from a changing and adapting and originating of many details. The original Porter-Allen high-speed engine was not an invention, but an aggregation of inventions, and in its designing the inventive faculty was constantly alert and resourceful. There was novelty of invention in the valve, in the valve motion and in the governor. The frame and bearings were novel and original. The making of the reciprocating parts very heavy instead of light was, at the time, perhaps, the most astonishing feature of all. For the original and independent inventions involved, Mr. Porter was always careful to insist that Mr. Allen should have full credit.

Not only was the inventing and designing task most exacting, but the requirements of construction were little less so. High-speed engine practice produced a revolution also in shop practice, and Mr. Porter became a pioneer in precise workmanship as it is known to-day, not only insisting upon minute accuracy and finish, but also devising the ways and the means for such production. While the modern, precise methods of manufacture, and the almost absolute identity of parts produced cannot be credited to any one or to any dozen selected men, Mr. Porter was among the first and most insistent and most successful of modern manufacturers, and in his line no more excellent workmanship has ever been achieved. Mr. Porter not only thus taught the tricks of high speed and of precision in manufacture, but he pushed others, no doubt often unknowingly, to notable engineering and manufacturing achievements.

As another consequence of high-speed engine developments and requirements, Mr. Porter became the begettor of the first efficient and satisfactory high-speed steam-engine indicator, he having stimulated Charles B. Richards to its production, and then Mr. Porter's book in exposition of the indicator and of indicator practice brought out his remarkable talent as a clear and forcible and most readable writer. My first acquaintance with that book worked a new departure in engineering knowledge and imparted an interest in steam engineering never felt before.

Mr. Porter's high success in so wide a reach of activity is most unaccountable, according to the story which he has told us. His early predilections and associations do not seem to have been at all in mechanical or engineering lines. I tried more than once to learn from him something of his early years, but without success. He was educated and prepared for other things and had begun life as a fully equipped lawyer, when directly through that he was brought face to face with his life work, so different, but which he would seem to have plunged right into without any of the usual time serving or ordeal of preparation.

If his success was so unaccountable, his unsuccess in securing any of the substantial rewards of life for which man strives would seem to be not less so. One might have thought that in this the legal training and experience should have helped him, but it seems not to have availed at all.

I knew Mr. Porter only for a score of years, and that after, as we may realize now, all his notable things had been done, although his head was still full of schemes. It was always a pleasure to meet him. He was genial and helpful and always highly appreciative of every little thing that could be done or said in evidence of one's well-wishing. He did much good work, which is enduringly embodied in the world's engineering history.—Frank Richards, *American Machinist.*

"PAY AS YOU ENTER" FOR COALING SHIPS

At Kingston, Jamaica, a novel method of coaling ships and of the payment of the laborers is resorted to. When a ship is to be coaled a hundred or more negroes gather and wait for the signal to start. They are furnished with full baskets (about 1½ bushels each) of coal, which they carry on their heads from the coal yard to the coal bunkers, where the basket is dumped and the empty basket carried back. Each laborer receives a penny a basket, and as he passes up the gang plank with the load on his shoulders, a penny is handed him by the negro "paymaster." Of course labor is plentiful, but the prospect of receiving money each trip has proved the most effective stimulant yet devised.

NEW BOOK

Compressed Air Plant. The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service, by Robert Peele. John Wiley & Sons, New York. XVI—502 pages, 6x9 inches. 209 cuts. $3.50 net.

This second edition of Prof. Peele's book, following the first so closely, shows that it has won deserved recognition. It is an eminently practical book and should be of value not only to miners, but to all who have to do with compressed air. In addition to a revision of the whole the new matter comprises 174 pages and 97 cuts.

NOTES

California oil production for the first half of 1910 totaled 36,784,364 bbls., 9,188,341 bbls. coming from the Coalinga district.

Heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7,000 h. p. per acre.

Minnesota furnishes from St. Louis county alone about three-fifths of the iron ore produced in the United States; the shipments during 1909 amounting to 29,282,526 tons.

By mailing a request to the Director of the Bureau of Mines, Washington, D. C., the various publications may be otbained, and also advance notices of bulletins and other papers to be issued.

Owing to the increasing popularity of the automatic ticket delivery machines which have been placed in the London Tube and District stations, the management of the Bakerloo, Piccadilly, and Hampstead lines have ordered 25 more, making 50 in all. Recently 76,000 tickets were issued by the machines in one week.

An explosion of corn dust occurred at the works of the Corn Products Refining Co., Granite City, Ill. The explosion was on the sixth floor of a building where several workmen were engaged in sacking the corn dust as it came from the refining plant, about 100 ft. away. Two men were killed and seven others fatally injured.

Manufactures now form, for the first time in the history of our commerce, more than one-half of the total exports of the United States. In the 8 months ended with August, the figures of the Bureau of Statistics of the Department of Commerce and Labor show that out of a total exportation of $1,027,000,000, manufactures amounted to $542,750,000, or 52.8 per cent. of the whole.

For use during cold weather, when the trains of the Pennsylvania railway entering the New York station through the electrified-tunnel zone are disconnected from their steam locomotives, steam generated in electric boilers will be used to maintain the temperature in the cars and to keep the train connections from freezing. These boilers will utilize the 600-volt direct current from the third rail, generating steam at 80 pounds pressure.

One of the latest automobile novelties in England is a tire pressure gauge which measures the pressure that is actually in the tire. It is about the size of a pencil, and is aplied to the valve after unscrewing the valve caps. A small pin depresses a valve plunger and the air forces out a little piston on which the pressure is plainly marked in pounds. The correct pressure for different sizes of tires is printed on the gauge. The device is so small that it can be carried in the vest pocket.

The introduction of compressed-air pipe lines into all the workings of a mine might be utilized to provide fresh air and even food to men imprisoned after explosions or through falls. This does not involve much expense, as mines are usually equipped with compressed-air apparatus, and the piping leading into the mine is of such a nature as to withstand considerable damage from the exterior. Telephoné wires inserted within the air pipe might also serve a useful purpose in saving life.

A new tunnel under the East River, New York, will be driven from Astoria, Long Island, to 132d Street and Locust Avenue, Borough of the Bronx, for the Consolidated Gas Company. It is to pierce the rock about 250 feet below tidewater level. The section planned is 19½ ft. wide and 19½ feet high, with a circular roof and vertical side walls about 8 feet high. It is to be lined with concrete and will contain two 72-in. gas mains set in concrete in the bottom.

In view of the fact that there are other substances in nature besides air that contain oxygen, and will give up this oxygen to combustible substances, it would seem probable that combustion could be brought about through the aid of such oxygen-containing bodies; and this was long ago proved to be true. One of the first, if not the first, of such bodies that became known to man is saltpeter, also called niter, or potassium nitrate, which, because it occurs as a white efflorescence like frost on the surface of the soil in India, has been called India saltpeter, although it has been found to some extent in many parts of the world.

The synthesis of hydrogen and nitrogen has hitherto been deemed impracticable, because of the slow reaction of nitrogen at low temperatures and its very slight affinity for hydrogen, even at high temperatures under ordinary conditions. Experiments made in Germany, however, are said to show that by the use of a pressure of about 200 atmospheres, which is considerably higher than previously employed, combination readily takes place especially with the aid of osmium or uranium as a catalytic agent. This principle is the basis of a new process for the fixation of atmosperic nitrogen in the production of ammonia. Other processes for the fixation of atmospheric nitrogen involve the use of the electric arc.

The last addition to the world-wide campaign of upper-air research, is the work in this line just begun at Cordoba, Argentina, under the direction of the meteorological service of that country. The work was organized by Mr. C. H. Clayton, late of the Blue Hill Observatory. An aerological staff of five observers is now making, so far as conditions permit, daily observations with kites, and will later undertake balloon observations. The aerological station at Cordoba is notable as the only institution of its kind in South America, and with the possible exception of Samoa, the only place in the southern hemisphere at which regular and frequent soundings of the upper air are in progress.

What is described as the largest stalactite cave in Europe was recently discovered near Schoenbergalm, in the Dachstein mountains, Upper Austria. Recently a party of Austrian and Hungarian scientists spent twenty-tour hours in thoroughly exploring the cavern. The principal tunnel was found to extend over a mile and a-quarter, with numerous side passages of varying lengths. In traversing the main tunnel the exploring party had to cross by rope ladders an ice crevasse 75 ft. deep and more than 100 ft. wide. The cave is divided into two levels. In the upper were found two immense ice-halls containing precipitous subterranean glaciers some 300 ft. long. Pheromenal ice formations were also found here. In the lower level was an endless series of halls, the largest more than 600 ft. long and 100 ft. high. Traces of subterranean water courses in the form of sand and rubble were discovered in the main tunnels. There were also some beautiful flower-shaped stalactites. Among the palæontological discoveries made were petrified Brachiopoda and remains of cave bears (Ursus spelæus).

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 4.

971,517. FLUID-MOTOR. Carlos F. Benitez, Guadalajara, Mexico.

971,535. AEROPLANE. Hermann Hartmann and Wilhelm Klehe, New York, N. Y.

971,537. MILKING-MACHINE. John L. Hulbert, Holland Patent, N. Y.

3. The combination in a milking machine of a rigid cylindrical teat cup shell, a plurality of inflatable tubes in the shell encircling the teat chamber thereof, a closure for the lower end of the teat chamber adjustable into the chamber, means for applying an intermittent suction to the lower end of the teat chamber, and means for supplying fluid under pressure to said inflatable tubes and deflating them, substantially as set forth.

971,583. PNEUMATIC SPRING. Benjamin Bell, Philadelphia, Pa.

971,595. VACUUM-CLEANER. Archer E. Clifton and Worth W. Preston, Connersville, Ind.

971,609. PROCESS OF CLEANING AND SEPARATING GRAINS. Axel T. Hedfeldt, Chicago, Ill.

The process of separating granular material which consists in spreading the same out into a thin film, feeding such film over a supporting perforated body transversely to an air current, subjecting such thin supported and spread out film of material to a confined current of air forced against it from below, passing such current of air with the material to be separated from the film space along a confined upwardly and laterally extending path, and discharging the material therefrom at intervals depending upon the weight of the materials.

971,612. APPARATUS FOR FORCING FLUIDS FROM WELLS. William C. Holliday, Columbus, Ohio.

1. In an apparatus for forcing fluid from wells, the combination with a well, a casing therein, a discharge pipe extending into said well, a plurality of plungers in said discharge pipe having a limited downward movement, each of said plungers having a vertical valve controlled passage, a valve and valve casing below the plungers, and a plurality of air pipes leading into said discharge pipe between the discharge pipe valve and the plunger, said air pipes having valve controlled connections with the compressed air supply.

971,638. AIR OR STEAM ROCK-DRILL. John Redington, Cobalt, Ontario, Canada.

971,660. ROTARY PRESSURE-BLOWER. Percy D. Brewster, East Orange, N. J.

971,743. VACUUM-SWEEPER. Richard Gober, Alameda, Cal.

971,806-7-8. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. Walter V. Turner, Edgewood, Pa.

971,839. WASHBASIN. James Hartness, Springfield, Vt.

1. The combination with a bowl, and a permanent trap whose limbs are not less in altitude than the desired maximum water column in the bowl, of an intermediate drainable trap having an air chamber whose volume is not less than the volume of the inlet limb of the permanent trap, said trap comprising a fixed air containing chamber, and a displaceable trap member movable relatively to said chamber.

971,894. FILLING-MACHINE. Ludwig Jaeger, Chicago, Ill.

1. In a bottle filling machine, the combination of a liquid tank, a liquid valve, an air connection between the tank and the bottle being filled to permit an equalization of pressure in the bottle and tank before the liquid flows into the bottle, and means for controlling the escape of air from the bottle during the filling operation to enable the liquid to flow into the bottle at a constant velocity regardless of the loss of hydrostatic head during the filling operation.

971,896. COMPRESSED-AIR SYSTEM FOR RAILWAY-CARS. Oscar Johnson, Chicago, Ill.

971,913. DENTAL AIR-PUMP. Eduard Messmer, Gratz, Austria-Hungary.

971,933. PNEUMATIC STACKER. Joseph K. Sharpe, Jr., Indianapolis, Ind.

971,982. PRESSURE-REDUCING VALVE. Thomas P. Ford, New York, N. Y.

971,984. SAFETY SYSTEM FOR REFRIGERATING APPARATUS. Albert Gaide, Chicago, Ill.

1. The combination in a refrigerating apparatus, of a compressor; inlet and outlet pipes for said compressor; a check valve in the outlet pipe; a valve in the inlet pipe arranged to stop the passage to the compressor; a differential piston and cylinder; an operative connection be-

tween said inlet valve and said piston so arranged that the action of the larger piston unseats said valve and the action of the smaller piston seats the valve; an open connection between the outlet pipe on the compressor side of said check valve and the larger cylinder; and an open connection between said outlet pipe on the other side of said check valve and the smaller cylinder, substantially as described.

972,027. AIR-BRAKE MECHANISM. HUGH T. RYDER and JOHN P. JOHNSON, Greensboro, N. C.

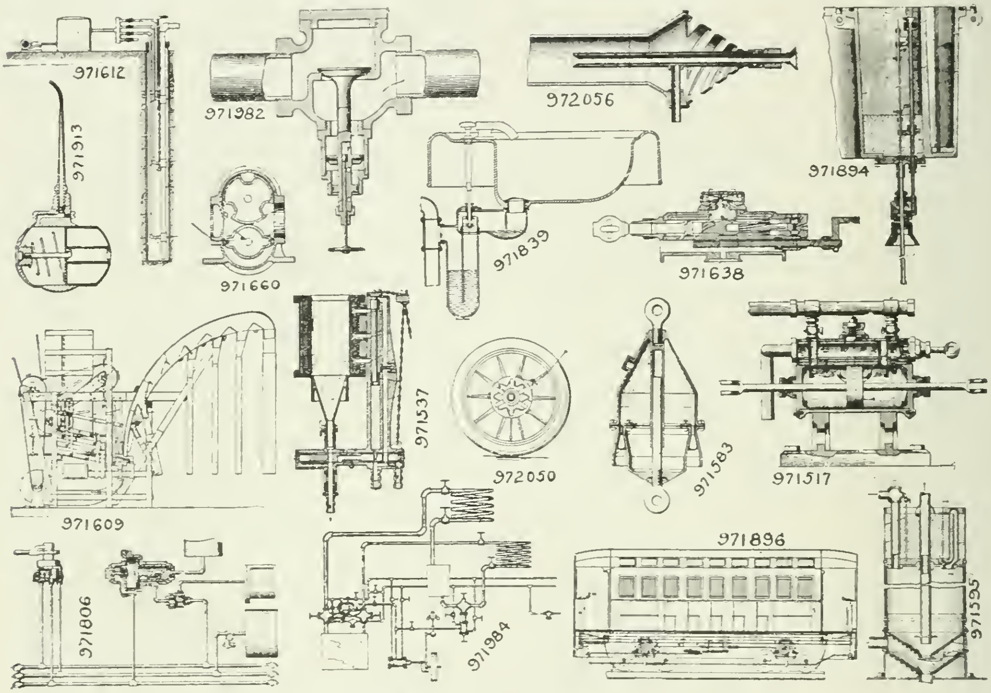
972,039. HYDRAULIC AIR-EXHAUST MECHANISM. JOHN WILLIAMS THOMAS, Allentown, Pa.

972,050. TIRE-INFLATING DEVICE. ROBERT BARNFATHER, Croydon, England.

1. An inflator comprising a frame, a series of cylinders mounted upon said frame, suction and delivery valves to said cylinders, a reservoir into which each cylinder delivers air, a drum concentric with said frame, said drum being external of the series of cylinders and said reservoir being internal of said series, a cam surface upon said drum, pistons fitting in said cylinders, connections from said pistons to said cam surface, and means for causing relative rotation between said frame and said drum.

972,056. NATURAL-GAS BURNER. CHARLES E. BUNNER, Grafton, W. Va.

1. A burner of the class described comprising a tubular body open at one end, a conical head on the inlet end of the body, said head having air inlet ports, a conical valve rotatably mounted on the head and having inlet ports adapted to be moved into or out of register with the ports of the head, a centrally-disposed longitudinally-extending pipe terminating within the said body, means for connecting the pipe with a source of gas, means for imparting a whirl to the gas while in the said pipe, and a deflector for distributing the gas into the air passing through the said body.



PNEUMATIC PATENTS OCTOBER 4.

OCTOBER 11.

972,161. AIR-COMPRESSOR. ALLAN O. CARPENTER, Franklin, Pa.

4. In combination with an air compressor and its inlet port and inlet valve therefor, an unloader valve governing a portion of the inlet port and adapted to maintain such port open, and a fluid pressure governor actuated by the excess pressure delivered by the compressor for operating the unloader valve.

972,163. AIR-COMPRESSOR. WALTER L. CRANE, Denver, Colo.

972,183-4. AIR-FILTER. CARL GUNTRUM, New York, N. Y.

972,212. PNEUMATIC COTON-SEED SEPARATOR AND CLEANER. THOMAS MCDONALD, Dublin, Tex.

972,218. CONTROLLING DEVICE FOR PRESSURE-FLUID ENGINES. ALMON E. NORRIS, Cambridge, Mass.

972,223. FLUID POWER TRANSMISSION AND CONTROLLING APPARATUS. WILLIAM E. PEARSON, Boston, Mass.

972,285. ACETYLENE-GENERATOR. FRANK E. STOVER, Luray, Va.

972,294. PROCESS OF CLEANING OLD PAPER-STOCK. JOHN D. TOMPKINS, Valatie, N. Y.

2. The process of cleaning old paper stock which comprises conveying the stock forwardly over one or more large openings and simultaneously removing the strings and then freely fluttering the stock above said openings by means of an air blast, to remove heavy foreign materials by allowing the latter to pass through said openings.

972,347. PRESSURE-REGULATOR FOR AIR-BRAKES. DAVID H. DOWNEY, Basalt, Colo.

972,381. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHESTER S. JENNINGS, Boston, Mass.

972,390. AIR-PUMPING ATTACHMENT FOR WATER-PUMPS. CALVIN H. MERRILL, Shenandoah, Iowa.

972,408. VALVE MECHANISM FOR AIR-COMPRESSORS. Theodore H. Smith, San Francisco, Cal.

972,437. PNEUMATIC STACKER. George F. Conner, Port Huron, Mich.

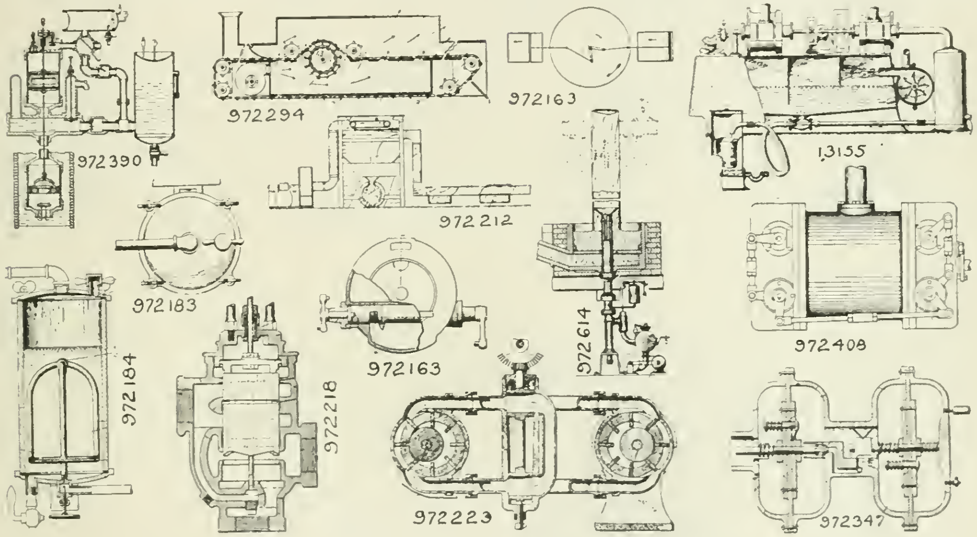
972,448. FLYING-MACHINE. John Emery Harriman, Jr., Brookline, Mass.

972,548. HANDLE FOR PNEUMATIC DRILLS. Axel Levedahl, Aurora, Ill.

972,614. REGULATION OF AIR-SUPPLY IN DRAWING GLASS CYLINDERS. Robert L. Frink, Cleveland, Ohio.

13,155 (Reissue). PNEUMATIC CLEANSING APPARATUS. Albert L. Moorhead, San Francisco, Cal.

3. In pneumatic cleansing apparatus, a hollow base, having a collecting-tank or receiver therein, an air-compressor pump and an air-exhaust pump mounted thereon, a compressed-air receiver, a pipe connection between said compressor-pump and said receiver, a pipe connection between said exhaust-pump and said tank, an outlet for said exhaust-pump, an air inlet for said compressor pump, an inlet-pipe for dust and refuse connected with the tank, into which it discharges, and a device for agitating and forcing said refuse into said tank between the tank and said inlet-pipe, substantially as described.



Pneumatic Patents October 11.

OCTOBER 18.

972,813. AIR-COMPRESSOR. Jarvis R. Burrows, Chicago, Ill.

972,858. APPARATUS FOR GENERATING ACETYLENE GAS. Samuel F. Hodges and William H. Lee, Nocona, Tex.

972,931. LIQUID-FUEL BURNER. Hooker Shapel, Iola, Kans.

972,939. VACUUM-PUMP. Gray Staunton, Evanston, Ill.

973,107. TUNNELING-MACHINE. William Russell Collins, Georgetown, Colo.

973,113. PNEUMATIC STACKER. Albert M. Harris, South Bend, Ind.

973,122. COOLING APPARATUS FOR INKING-ROLLERS. Edward R. Melton, Washington, D. C.

1. In a cooling device for the inking mechanism of printing presses, an air pipe located adjacent the inking mechanism and extending transverse to the press; means through which the air is supplied to said pipe; a plurality of nozzles adapted to direct streams of air against the inking mechanism and each of which is adjustable to thereby vary the direction taken by a stream of air issuing therefrom; and a connection between each nozzle and said pipe and through which air may flow from said pipe to each of said nozzles.

973,179. AIR-BRAKE SYSTEM. Arthur Doan, Elmhurst, Cal.

973,194. AIR-BRAKE. John E. Henris, San Francisco, Cal.

973,211. VALVE MECHANISM FOR AIR-COMPRESSORS. George H. Reynolds, Mansfield Depot, Conn.

973,223. AIR-SPRING. Archibald Sharp, Westminster, London, England.

973,263. APPARATUS FOR FREEING WATER FROM ITS CONTAINED IRON IN A CONTINUOUS CIRCUIT. Ludwig Heinrich Darapsky, Hamburg, Germany.

1. In an apparatus for purifying water, a closed filter, a closed separator for air and water separate from the filter and into which the filter discharges, means to pump air from the separator to the filter and means to supply water to the filter with the air.

973,289. FLUID-PRESSURE HEAT-ENGINE. Jean Molas, London, England.

4. Liquid fuel burning apparatus for the production of heat for generating steam, comprising the combination of a reservoir, an internal combustion motor, means driven by said internal combustion motor for compressing atmospheric air, a container adapted to receive air compressed by said air-compressing means, said internal combustion motor, said air-compressing means, and said container being immersed in said reservoir, an inlet to said internal combustion engine and a pipe connecting said container to said inlet, and a pipe connecting the combustion chamber of said internal combustion motor to said reservoir, substantially as described.

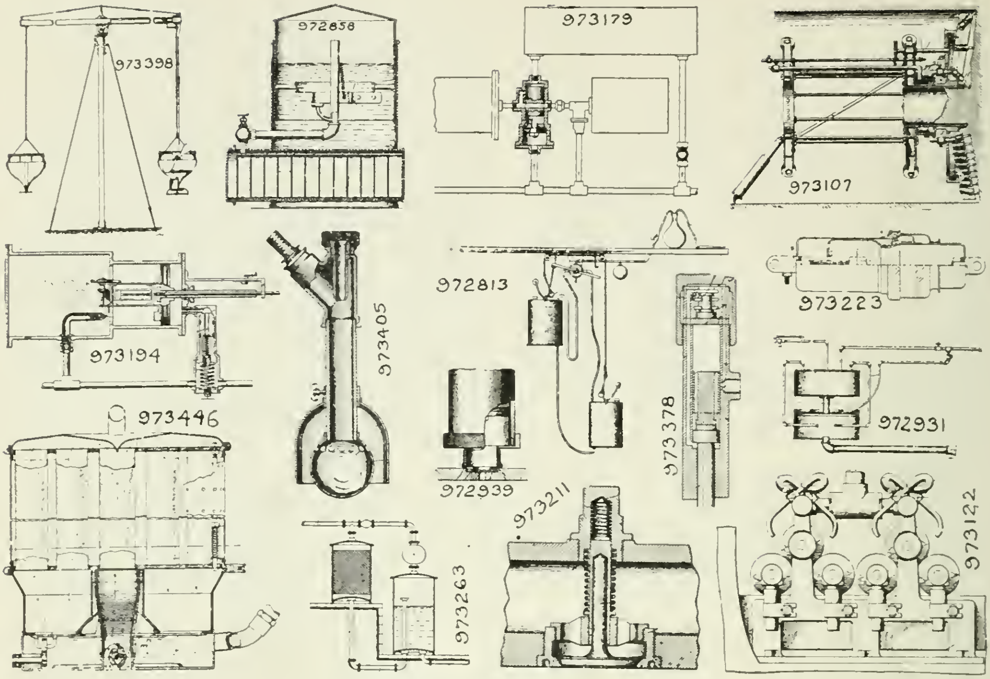
973,292. VACUUM-CLEANER. Iver Nielsen, New Rochelle, N. Y.

973,378. PNEUMATIC HAMMER. Friedrich Adolf Otto, Remscheid, Germany.

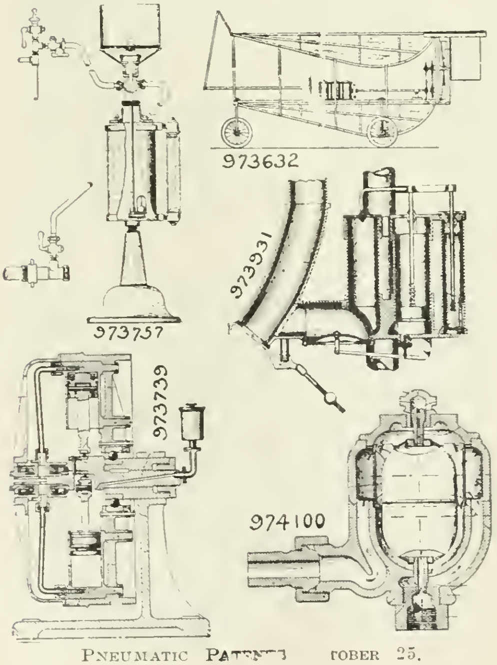
973,398. CAPTIVE AIRSHIP MECHANISM. Vincent C. de Ybarrondo, Los Angeles, Cal.

973,405. VACUUM-PRODUCING DEVICE. Sawyer D. Clark and Charles F. Bartell, Boulder, Colo.

973,446. PNEUMATIC CLEANING APPARATUS. Frank J. Matchette, Charles Gordon, and Charles Moukos, Milwaukee, Wis.



Pneumatic Patents October 18.



Pneumatic Patents [illegible]tober 25.

OCTOBER 25.

973,483. ART OF AND APPARATUS FOR CASTING FLUID METAL. Herman H. Doehler, New York, N. Y.

1. The herein described process, method or art of casting fluid metal consisting of pouring a measured quantity of molten metal from within an inclosed chamber into a metallic mold and thereafter forcing and compressing the metal by following it up with an elastic fluid under high pressure.

973,632. AEROPLANE. John M. Davis, McGraw, N. Y.

973,704. MILKING DEVICE. Axel Sabroe, Hadersleben, Germany.

1. In a device for the purpose described, a receptacle, a milk conduit connected therewith near the upper end thereof, a pneumatic pipe connected therewith near the bottom end of less area than said conduit, and an elastic member at the top of said receptacle serving as a closure therefor and also for closing said conduit.

973,739. AIR-COMPRESSOR. Georges Prosper Octave Alvergnat, Paris, France.

973,748. PNEUMATIC STACKER. William W. Brower, Harmattan, Alberta, Canada.

973,757. BEER-RECLAIMER. Joseph H. Champ, Cleveland, Ohio.

1. The combination with the top air inlet and liquid inlet of a bottling machine; of reclaiming apparatus comprising a receptacle having an exteriorly opening liquid inlet and an air vent, and a fluid pressure inlet and liquid outlet respectively connected with the top air inlet and the liquid inlet of said machine; and means adapted to simultaneously control the inlets, outlet, and vent of said reclaiming apparatus.

973,931. VACUO DESPATCH SYSTEM. Edgar Flint, Toronto, Ontario, Canada.

974,100. STEAM, AIR, AND WATER TRAP VALVE. John E. Boegen, Berwyn, Ill.

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Compressed air

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ENGINEERING

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